CHAPTER IV

STRUCTURAL

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1. <u>**PURPOSE OF CRITERIA**</u>. The purpose of the following criteria is to facilitate the proper use of design criteria, to ensure that repetitive deficiencies in design will be eliminated, and to ensure that all aspects of structural design are properly covered. They are not intended to be rigidly restrictive except in the use of building codes, unit stresses and unit loads, and for special design considerations in expansive soils areas. The standard details shown herein may be revised if it can be shown that a different detail is more economical and/or will perform better.

1.1 **Metrication.** The metric units used are the International System of Units (SI) adopted by the U.S. Government as described in Chapter I, paragraphs 3. and 4.2.1.

1.1.1 <u>Concrete Reinforcement</u>. This document uses metric concrete reinforcement designations conforming to the ASTM A635M-98 SI system.

1.1.2 <u>Masonry</u>. Concrete masonry units (CMU) and clay brick manufactured to metric standards are not readily available in the Southwestern Division. New facilities are typically dimensioned in metric units that are modular with hard metric masonry products. In accordance with P.L. 104-289 the Contractor may use soft metric CMU and brick, equivalent to standard I-P CMU and brick during construction. Plans and specifications should make the Contractor responsible for changes in reinforcement detailed on P&S and all costs associated with use of CMU and brick manufactured to I-P units.

2. <u>**REFERENCE**</u>:

2.1 **Publications of United States Government**

2.1.1 TI 800-01, Design Criteria

2.1.2 TI 809-01, Load Assumptions for Buildings

2.1.3 TI 809-02, Structural Design Criteria for Buildings

2.1.4 TI 809-04, Seismic Design for Buildings

2.1.5 TI 809-05, Seismic Design for the Rehabilitation of buildings

2.1.6 TM 5-809-3(Future TI 809-6), Masonry Design for Buildings

2.1.7 TI 5-809-07, Design of Load Bearing Cold-Formed Steel Systems and Masonry Veneer/Steel Stud Walls

2.1.8 TM 5-809-12(Future TI 809-27), Concrete Slabs on Grade Subject to Heavy Loads

2.1.9 TI 5-809-28, Design and Construction of Conventionally Reinforced Ribbed Mat Slabs (RRMS)

2.1.10 TI 5-809-29, Structural Considerations for Metal Roofing

2.1.11 TI 5-809-30, Metal Building Systems

2.1.12 TM 5-818-7, Foundations on Expansive Soils

2.1.13 TM 5-853-2, Security Engineering – Concept Design

2.1.14 TM 5-853-3, Security Engineering – Final Design

2.1.15 ER 1110-345-53, Structural Steel Connections

2.1.16 ER 1110-345-700, Design Analysis, Drawings and Specifications

2.1.17 ETL 1110-3-447, Engineer of Record and Design Responsibilities

2.1.18 CESWD Design Criteria for Ribbed Mat Slab Foundations, 1995

2.1.19 CESWD Fallout Radiation Shelter Design Criteria, 1988

2.1.20 MIL-HDBK 1008C, Fire Protection For Facilities Engineering

2.1.21 EC 1110-1-92, Classification of Type of Construction.

2.2 **Construction Industry Codes and Specifications**

2.2.1 AISC Specification for Structural Steel Buildings - Allowable Stress Design and Plastic Design (1989).

2.2.2 AISC Load and Resistance Factor Design Specification for Structural Steel Buildings (latest edition).

2.2.3 AISC Manual of Steel Construction, Volume II-Connections (1992 with 1993 and 1994 errata)

2.2.4 ACI 318, Building Code Requirements for Structural Concrete (latest edition)

2.2.5 SJI Standard Specifications and Load Tables for Open Web Joists (latest edition).

2.2.6 ASCE 7, Minimum Design Loads for Buildings and Other Structures (latest edition)

2.2.7 AISI, Specifications of the Design of Cold Formed Steel Structural Members (latest edition)

2.2.8 AWS D1.1, Structural Welding Code by The American Welding Society (latest edition)

2.2.9 Aluminum Design Manual by The Aluminum Association (latest edition)

2.2.10 ASCE 16, Load and Resistance Factor Standard for Engineered Wood Construction (latest edition)

2.2.11 National Design Specification for Wood Construction, 1997

2.2.12 FEMA 302, NEHRP Recommended Provisions for Seismic Regulations for New Buildings and Other Structures (1997)

2.2.13 AISC Specification for the Design of Steel Hollow Structural Sections and Hollow Structural Sections Connections Manual. (latest edition)

2.2.14 SDI DDM02, Diaphragm Design Manual (latest edition)

2.2.15 ACI 530, Building Code Requirements for Masonry Structures by The American Concrete Institute (latest edition)

2.2.16 Low Rise Building Systems Manual by The Metal Building Manufacturers Association (latest edition)

2.2.17 BRAB Report, Criteria for Selection and Design of Residential Slab-on-Ground.

2.2.18 International Building Code (2000)

2.2.19 AISC, Seismic Provisions of Structural Steel Buildings, 1997

2.2.20 API Standard 640, Welded Steel Tanks for Oil Storage

2.2.21 AASHTO Standard Specifications for Highway Bridges (latest edition)

2.2.22 ACI 315, Manual of Standard Practice For Detailing reinforced Concrete Structures (latest edition)

2.2.23 AISC Hollow Structural Sections Connections Manual

2.2.24 SDI Design Manual for Composite Decks, Form Decks and Roof Decks. (latest edition)

2.2.25 AISC Code of Standard Practice for Steel Buildings and Bridges. (latest edition)

2.2.26 AISC Specification for Structural Joints Using ASTM A325 or A490 Bolts. (latest edition)

2.2.27 PTI Design and Construction of Post-Tensioned Slabs on ground by Post Tensioning Institute (1980)

2.2.28 A Practical Approach to the "Leaning" Column by Lousi F. Geschwinder, AISC Engineering Journal, Volume 32, No. 2, Second Quarter 1995.

2.2.29 Uniform Building Code (UBC) (latest edition)

3. **REQUIREMENTS FOR PROJECT ENGINEERING PHASE/CODE 3 (ARMY) AND PROJECT DEFINITION (AIR FORCE) SUBMITTAL**. (Reference: TI 802-01) When the design Scope of Works requires, either a Project Engineering or Project Definition brochure submittal is required. Typically this submittal is made at the 15 percent design completion stage, but the Scope of Work may modify this requirement. The parametric estimate must be based on reasonable description of the physical properties that

describe the project. At this pre-design stage the structural design engineer shall have used the proposed building footprint, room arrangement, and interface between the facility and its proposed building site and conceptual framing options cost estimates to select an economical structural framing system. Facilities for which structural design will be complex/unconventional or costly shall be developed as required establishing the project cost.

3.1 **Structural Submittal**. The structural portion of the brochure submittal will consist of a narrative and sketches/drawings showing that structural framing functional requirements, criteria and economics have been satisfied during the selection of a suitable structural system.

3.1.1 The presentation shall list structural technical criteria, manuals, codes, etc. applicable to the design.

3.1.2 The presentation shall summarize the design live loads, give the design basic wind speed, exposure category and importance factor, state the design Seismic Spectral Accelerations, S_s and S_1 , facility Seismic Use Group, and Seismic Design Category. Also, identify the threat tactic(s), threat severity level(s) and level(s) of protection for Antiterrorism/Force Protection established by DD Form 1391 for security of the facility.

3.1.3 The presentation should discuss the structural framing system that is judged to be appropriate and the alternatives that have been evaluated, i.e. load bearing shear walls and floor/roof diaphragms, braced frames and floor/roof diaphragms, moment resisting steel frames, reinforced concrete pan joist floor, bar joist with light weight concrete slab on metal form floor, etc.

3.1.4 Discuss any special requirements that affect the structural design and cost such as sloping construction site, costly foundations, unusually long span length, seismic joints, complex architectural features, Force Protection measures required for main structural framing system, walls, doors, windows, roofs, etc.

3.1.5 Submit preliminary calculations or rational used to size/evaluate/justify the recommended framing system and its estimated construction cost.

3.1.6 Submit sketches/drawings showing type floor and roof structure, column grid lines and locations of lateral braces in frames, shear walls and any unconventional framing requirements

4. **REQUIREMENTS FOR CONCEPT (ARMY) SUBMITTAL**. When required by the Scope of Work on Army projects, this submittal is at the 35 percent design completion stage. The structural portion of the submittal consists of a structural narrative, design analysis and drawings.

4.1 **Structural Narrative**. Use the format shown in Chapter IX and include all of the information listed in the format that is applicable to the project.

4.1.1 Framing System. Selection of the structural framing system should be based on a cost comparison of competitive systems. Reasons for the final selection should be stated, including economic, functional, site or other considerations. The framing system's vertical and lateral load resisting systems should be clearly described.

4.1.2 Foundation Type. If the on-site soil investigations, soil testing and evaluation are complete, a foundation design analysis with final foundation recommendations should be in the Concept submittal. When this work is not complete a tentative foundation recommendation (based on information from past soil investigations and types of foundations previously used in the vicinity of the building site) should be given.

4.1.3 Live Loads. The live loads to be used for design should be stated. Loads should comply with TI 809-01 and ASCE 7, and any special conditions such as needed for computer room floors, mechanical room floors, etc.

4.1.4 Seismic Design. Preliminary seismic design is required. Give the site Seismic Spectral Accelerations, S_s and S_1, facility Seismic Use Group, and Seismic Design Category. State if seismic or wind controls the design of the lateral force resisting system. When seismic controls the design of the lateral force resisting system, describe the system selected using "Basic Seismic-Force-Resisting System" terminology from Table 7-1 of TI 809-04. Also describe any special seismic design features such as seismic separation joints. Spectral accelerations S_1 and S_s for each base in the Southwestern Division are given in paragraph 22. A design aid for Seismic Design Category is in paragraph 23.1.

4.1.5 Wind Loads. The narrative should state the basic wind speed, importance factor and exposure category, and should utilize references TI 809-01 and ASCE 7 as the basis for calculating wind pressures. The basic wind speed for each base in the Southwestern Division is listed in paragraph 22.

4.1.6 Force Protection. The narrative should state the design threat tactic(s), threat severity Level(s) and level(s) of protection for force protection established on DD Form 1391 for the facility. Identify the structural superstructure measures incorporated into the main structural framing system, walls, doors, and windows to provide the level of protection required.

4.2 **Design Analysis**. Provide calculations necessary to document comparative cost investigations and to demonstrate the adequacy of the structural design concepts.

4.3 **Structural Drawings**. Drawings should show the following:

4.3.1 Foundation plan and typical sections.

4.3.2 Floor framing plan(s), where applicable.

4.3.3 Roof framing plan.

4.3.4 Lateral load resisting system (shear walls, frame bracing, moment resisting frames, wall system, etc.).

5. **REQUIREMENTS FOR FINAL SUBMITTAL**.

5.1 **Structural Narrative**. The write-up should cover functional, technical requirements, and design methods upon which the facility foundation, superstructure, floor, roof and wall systems where designed. The write-up should address design dead, live, wind, and seismic or other loads. Selection of structural systems for economy and to meet technical requirements such as seismic and force protection shall be addressed.

5.2 **Design Analysis**:

5.2.1 See Chapter IX - Design Analysis, and ER 1110-345-700 for additional structural requirements.

5.2.2 Lateral Load Analysis In addition to an analysis for vertical gravity loading, a complete lateral load analysis is required for all buildings to design a continuous load path from the point that the lateral load is applied to the foundation. Design lateral loads caused by wind and due to earthquake ground motion shall be analyzed. Additional discussion of lateral load design analysis requirements are in Chapter IX. Basic design wind speed seismic spectral accelerations for military installations within CESWD are in paragraph 22. A design aid for seismic analysis is in paragraph 23.1.

5.3 **Structural Drawings**:

5.3.1 Use standard details and notes shown on enclosed plates, where applicable.

5.3.2 Use grade beam, slab, lintel, column and footing schedules where the size of building warrants.

5.3.3 Show sufficient sections and provide sufficient details required to construct the superstructure framing, building foundation, walls and floors so they perform in accordance with the design analysis intent and detail miscellaneous items including, steps, porches, mechanical equipment pads, cooling tower foundations, etc.

5.3.4 Show steel column base details and detail all critical steel beam connections. Simple connection details (Shear Connections) may be selected by the structural steel fabricator from the AISC Manual of Steel Construction. Where connections are not detailed, show design shear capacities. The Engineer of Record should approve the structural adequacy of shear connections detailed by the steel fabricator as required by ETL 1110-3-447.

5.3.5 All reinforced concrete sections should be detailed in accordance with the Manual of Standard Practice for Detailing Reinforced Concrete Structures by the American Concrete Institute (ACI 315).

5.3.6 Roof openings and all supports for ventilators, fuel tanks, electrical bus ducts, unit heaters and other equipment must be detailed or adequately described on the drawings or in the specifications. The structural designer shall ensure that all mechanical and electrical equipment is properly supported and that Architectural features are adequately framed and connected, especially where seismic design is required.

5.3.7 Masonry for buildings should be detailed to show required thickness, vertical reinforcement size and spacing, dowels, pilaster depth, reinforcement and ties, wall stiffeners adjacent to openings, lintel depth, reinforcement and end bearing dimensions, bond beam spacing and reinforcement, joint reinforcement spacing and size, and control joint locations and details. When walls are curtain walls show details of masonry connections to the main frames.

5.3.8 Light cold formed steel framing should be detailed to show steel stud, steel joist, spacing and required physical properties including depth, thickness, moment of inertia, section modulus. Assembly details to show wall top and bottom tracks along with their required physical properties and their connections to floors or other framing. Details including required web stiffeners, foundation clips, end clips, joist hangers and the required number and size of connecting screws and/or weld size and length should be included. Framing around openings shall be detailed to show headers, nested or double/triple members on sides of openings shall be shown. Diagonal bracing and its connection to foundation and light gage framing shall be fully detailed when required for building structural stability. Intermediate bridging for lateral support of studs/joists needs to be fully detailed. See paragraph 19.1 for special designer requirements.

5.4 **Seismic Design**:

5.4.1 Seismic design parameters, as indicated by the general notes on Plate S1 shall be on the structural drawings in the Contract Plans.

5.4.2 Details of construction on the structural drawings will be sufficient to assure that construction meets applicable seismic requirements in TI 809-4, TI 809-5 and FEMA 302.

6. **LOADINGS**.

6.1 **Minimum design loads and load case combinations** shall be in accordance with references TI 809-01, and ASCE 7 except as stated below.

6.2 **Load combinations for strength designs** of concrete shall be based on ACI 318 and AISC for Allowable Stress and Load and Resistance Factor design for structural steel.

6.3 **Minimum design pressure for interior walls** and partitions shall be 240 Pa, except use 480 Pa for interior masonry walls.

6.4 **For applicable basic wind speeds**, seismic spectral accelerations, and ground snow loads refer to paragraph 22.

7. **MATERIALS AND DESIGN CODES**.

7.1 **Concrete**.

7.1.1 Design of concrete elements shall conform to ACI 318.

7.1.2 Use a concrete strength of 21 MPa (3000 psi) for reinforced concrete and 35 Mpa (5000 psi) for prestressed concrete. For concrete slab-on-grade subject to heavy wheel load see paragraph 10.3.6.

7.1.3 Reinforcing should be ASTM A615M grade 420 (ASTM A615 grade 60) or equivalent except that ties may be ASTM A615M grade 300 (ASTM A615 grade 40).

7.2 **Steel**.

7.2.1 Design of hot rolled steel members and connections shall conform to applicable AISC manuals referenced in paragraph 2.2. Hot rolled steel members should generally conform to ASTM A992 or ASTM 572 Grade 50, structural tubing ASTM A500 Grade B, channels, angles, plates may be ASTM A36.

7.2.2 Design of cold formed steel shapes shall conform with TI 5-809-07 and AISI, Specifications of the Design of Cold Formed Steel Structural Members.

7.2.3 Design of open web joists and joist girders shall conform to Steel Joist Institute Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders.

7.2.4 Design of steel decking used as a diaphragm shall conform to the Steel Deck Institute Diaphragm Design Manual and the Design Manual for composite Decks, Form Decks and Roof Decks.

7.3 **Masonry**. Concrete masonry units (CMU) shall be designed in accordance with TM 5-809-3 (future TI 809-6), TI 809-04 and ACI 530. Use type "S" mortar. See paragraph 1.1.2 for guidance on size of masonry units to use.

8. **FOUNDATION DESIGN**:

8.1 **General**. Applicable notes from Plates 4 and 5 should be included in the structural drawings, preferably on the foundation plan. Heavy, vibration-producing equipment, such as chillers, fire pumps, engine/generator sets and high-pressure air compressors, should have separate isolated foundations. Some equipment should be provided with vibration isolators, see TM 5-805-4.

8.2 **Type of Foundation**. The recommended foundation type, allowable bearing pressure, foundation depth, expansive/settlement parameters, etc. will be included in the final Foundation Design Analysis. The Foundation Design Analysis should also indicate whether slab-on-grade first floors may be used or whether first floors must be structurally supported over a void due to expansive soil conditions. The foundation type and design must satisfy the limiting deflections required too ensure proper performance of the building superstructure. Differential settlements/heave should be limited to L/600-L/1000, L/360-L/600 and L/200-L/360 for rigid, semi-rigid and flexible framing/wall systems, respectively; where L is the distance between points in question. A special criterion is to be followed in expansive soils areas.

8.3 **Design loads**. Allowable foundation bearing pressures should be given in the Foundation Design analysis and will be normally be given as "net" values; intended for use with service loads consisting of dead loads plus that portion of live loads that act continuously. Use of common live load reduction factors is one way to approximate the continuous live load. The "continuous live load" concept does not apply to certain foundations with high transient loads, such as crane loads, where the full live load should be considered in the foundation load. Since bearing allowable is net values, do not include the weight of footings, piers or overburden in the design loads. Where wind or seismic loads cause foundation uplift, these loads should be combined with any pier heave forces due to expansive soils to determine the total tension load for design of pier shaft reinforcement. Lateral forces may be present due to wind or seismic loads or due to rigid frame thrust. Such loads may require use of foundation ties. Ties for deep foundations may be necessary in seismic zones. Where Force Protection requires design for blast pressures for design of frames, walls, or roofs these loads shall conform to TI 5-853-3.

9. **PIER-AND-BEAM FOUNDATIONS**:

9.1 **Grade Beam Design**:

9.1.1 Grade beams should be designed in accordance with the ACI Code. The minimum tension reinforcement ratio "p" should be 1.38/fy with fy in MPa (200/fy with fy in psi) unless the computed reinforcement area required is increased by one-third. Provide a minimum of No.10 ties at 600mm o.c. throughout the length of the beam.

9.1.2 Use details similar to those shown on the plates in Appendix A.

9.1.3 A 150mm (6-inch) carton formed void will usually be required under all grade beams in expansive soil areas. This will be covered in the Foundation Design Analysis.

9.1.4 Masonry walls and partitions in buildings in expansive soil areas, with slab-on-grade floors should be on grade beams (even 102mm (4 inch) walls) in order to reduce wall cracking problems experienced in the past. Non-load bearing masonry walls and partitions in non-expansive soil areas may be supported on thickened slabs on grade. Load-bearing walls and shear walls will be supported on grade beams or strip footings in non-expansive foundations.

9.1.5 In buildings with slab-on-grade floors where the finished floor is more than 300mm above outside grade, special attention must be given to design of exterior grade beams to withstand lateral soil pressure from the fill under the floor slab.

9.1.6 The corner reinforcing details shown on Plate S12 should be used to prevent cracking at corners.

9.2 **Drilled Pier Design**:

9.2.1 Piers should be designed as short, tied columns with minimum vertical reinforcement per ACI requirements. Note that since pier shaft diameters are often larger for Geotechnical reasons than required for structural loads, the provisions of ACI 318 that allow a reduced concrete area to determine reinforcement may apply. For piers in expansive soil see paragraph 9.2.6 below.

9.2.2 Minimum pier diameters are 450mm (18 inches) for piers up to 12 meter (40 feet) in depth and 600mm (24 inches) for piers deeper than 12 meter (40 feet).

9.2.3 Bell diameters should be specified in increments of 150mm (6 inches) and should not be greater than 3 times the pier diameter to enable the use of typical machine belling equipment.

9.2.4 Size bells for dead load plus the portion of live load that acts continuously.

9.2.5 Pier loads should be computed only to grade (weight of pier, bell and earth above base of footing will be taken into account in determining "net" allowable bearing pressure given in Foundation Design Analysis).

9.2.6 Piers that extend through expansive soils may be subjected to tension loads caused by soil friction on the shaft as the soil expands. The Foundation Design Analysis will give either recommended pier design tension or minimum shaft tension reinforcement and minimum bell size to anchor the pier when expansive soils cause pier tension. Pier tension reinforcing should be sized for net load obtained by subtracting the pier load due to the building dead weight from the tension due to soil heave, using a steel stress of 420 MPa (60 ksi), depending on the steel specified.

9.2.7 See details and notes on Plate S11.

9.3 **Design of Grade Beams and Drilled Piers Carrying Lateral Loads.** The lateral force resisting system includes the structural system that transfers loads to the earth foundation. A system that ties the foundation elements together is highly desirable. Slab-on-grade floors are isolated from the superstructure foundation and this system requires careful evaluation of grade beams which are subject to lateral thrusts due to applied vertical loads, those which support diagonal wall bracing or short shear walls, and those which support exterior walls. Designers must be cognizant of the fact that seismic lateral forces computed by the Equivalent Static Force Method are lower than the peak dynamic force. Appropriate soil safety factors must be applied to limit lateral deflections of foundation elements and to compute structural stresses in piers and grade beams. The structural designer should see the Foundation Design Analysis and/or consult with the geotechnical engineer for recommended lateral soil design parameters.

10. RIBBED-MAT SLAB FOUNDATIONS.

10.1 **General Requirements.** Ribbed mats should be designed in accordance with reference Design Requirements for Ribbed Mat Foundations by CESWD, as modified by TI 809-28. Many of the provisions of these references are provided in the following paragraphs.

10.1.1 The ribbed mat foundation is a monolithic reinforced concrete slab-on-ground with stiffening ribs. The stiffened mat slab is particularly suited for structures on shallow foundations in expansive soils, where changing moisture content causes portions of the foundation soils to heave or shrink. Ribbed-mat foundations are simple and economical solutions to many foundation problems and have performed well for many military and civil works buildings. The restraint from the ribs below the slab has caused cracking in the slab that does not effect structural adequacy but is esthetically unacceptable for some buildings. Many of the prescribed criteria provisions have been developed to control slab cracking. Use of ribbed mats for floors in administrative areas or other highly visible floors that are not covered by vinyl tiles or carpets are not recommended. Due to the potential for ribbed mat slab cracking, it is preferable to use slab-on-grade foundations in non-expansive soils instead of ribbed mats.

10.1.2 Soil parameters for use in the structural design methods for ribbed mat foundations will be as furnished in a "Foundation Design Analysis." Criteria for development of the design soil parameters are in Chapter XIII, Geotechnical.

10.1.3 Ribbed-mat slabs are designed as prestressed or conventionally reinforced as selected by the design engineer. The construction contractor shall not be given the option of changing the ribbed-mat slab from one type to another. The reason for this prohibition is that design parameters (e.g., moments of inertia) may be dependent on the type of ribbed-mat slab being designed and may affect calculated shears and moments.

10.2 **Design Requirements**.

10.2.1 The design procedure involves two parts: (a) Meeting minimum prescribed requirements and (b) performing design analysis. See reference criteria in par 10.1 above.

10.2.2 Minimum Requirements - The minimum requirements apply to ribbed mat foundations on expansive and non-expansive soils. Many of these requirements are illustrated on Plate S16.

10.2.3 Joint spacing: Ribbed-Mat-Slabs shall be placed in 6.0 meters to 7.5 meters wide lanes. Lanes for slabs subjected to vehicular loads shall have transverse sawed joints spaced at 500 to 750 times the slab thickness in millimeters. Other slabs shall have sawed joint spacing at a maximum of 6.0 meters. Joint sawing needs to be accomplished immediately after concrete finishing. The construction joint detail is shown on Plate S19. A typical plan layout is shown on Plate S15.

10.2.4 Minimum Slab Reinforcement: Minimum slab reinforcement shall be 0.5% times the gross slab sectional area each way with a maximum reinforcement bar spacing of 230 millimeters each way. The maximum size of bar in slabs shall be #16, with a clear spacing distance of the slab thickness divided by four below top surface of slab, but not less than 40 millimeters nor greater than 65 millimeters. Slab reinforcement shall be continuous through construction and sawed joints.

10.2.5 Ribbed Mat slab surfaces should be **moist cured for 7 days using wet mats**. Guide specifications should be changed to require wet mat curing when preparing contract specifications.

10.2.6 Specify Minimum 28-Day Compressive Strength of 21 MPa (3.0 ksi) concrete strength except for vehicle loaded slabs where 28 MPa (4.0 ksi) strength shall be specified.(Note: 28Mpa concrete cylinder strength is approximately equal to 3.4 MPa (500 psi) flexural strength.) Specify water/cement ratio maximum of 0.42. Require an aggregate gradation that uses 25mm to 40mm (1 to 1.5 inches) maximum size coarse aggregate. Include these requirements in the contract specifications.

10.2.7 Ribs should be continuous across the slab, usually spaced no more than 6.0 meters on centers on expansive soils and 7.5 meters on centers on non-expansive soils. Rib depths should extend below the frost line but normally are limited to 1.0 meter in order to minimize problems with maintaining the trench walls during construction. Minimum rib width should be 300mm. Optional horizontal construction joints located near the bottom of the slab are not desirable but are sometimes used to facilitate construction. Use ribs on either side of large openings in the slab. In buildings with rigid frames such as pre-engineered metal buildings, transverse foundation ribs can be designed to take the rigid frame thrust. Minimum rib reinforcing percentage "p" for expansive soils should be 0.33 percent of the rib cross sectional area top and 0.33 percent bottom. The total reinforcing percentage may be reduced to 0.5 percent of the cross sectional area of ribs when founded on non-expansive soil areas. Provide more reinforcement when the analysis shows more is required to carry the loads.

10.2.8 Significant wall loads, column loads, etc., should be distributed to the soil by the ribs. An effective width of slab on each side of the rib, equal to the slab thickness, may be added to the rib width for the effective bearing area. The bearing pressure under the ribs shall not exceed the allowable soil bearing pressure. Ribs may be widened locally or thickened integral spot footings may be used to distribute column loads to the soil. See Plate S15.

10.2.9 Generally vapor barrier, capillary water barrier, and non-expansive fill should be used under ribbed-mat slabs. Exceptions may occur in arid climates when the site has highly pervious foundation material and a low water table. The designer should follow the recommendations in the Foundation Design Analysis.

10.2.10 Expansion joints should be used to break up an irregularly shaped building (L- or U-shaped for example) into two or more rectangular shapes when structural analysis results in unusually large ribs.

10.2.11 Where floors are subjected to vehicular loading, the floor slab must be designed in accordance with reference TI 809-05. The Geotectnical Engineers should provide subgrade modulus, K, for slab design when there are wheel loads. Normally, 130mm will be the minimum floor slab thickness except for small utilitarian type buildings 230 square meters or less where 100mm will be sufficient.

10.3 **Additional requirements for ribbed mat slabs on expansive foundations are**:

10.3.1 In expansive soil areas, existing surface materials may be removed and replaced with compacted non-expansive fill to decrease the foundation’s swell potential. The depth of non-expansive fill required is site dependent and is normally based on the expansive intensity that is usually higher near the surface. The depth shall be as required by the Foundation Design Analyses.

10.3.2 At corners of the building diagonal ribs, as shown on Plate S15, should be used to keep the corners supported in case of loss of support under the perimeter ribs.

10.3.3 Center lift and edge lift analysis predict moments due to soil displacements near the edge of the slab. However, soil displacements have also been observed at various interior locations. To account for possible interior soil displacement, interior ribs and reinforcement must be continuous.

10.4 **Analytical Requirements**. All ribbed mats must be designed to distribute concentrated loads to the soil as spot footings, strip footings, or by beam on elastic foundation methods. Ribbed mats on expansive soils must also be designed for center lift and edge lift conditions. Design for these conditions should be as described in references in paragraph 10.1 above.

10.4.1 In expansive soils, perimeter ribs must be designed to span between transverse ribs while subjected to loads and soil pressures as calculated for the center lift and edge lift conditions. For center lift the soil pressure under perimeter ribs is frequently zero.

10.4.2 Diagonal ribs should be of the same size and reinforcement as the larger adjacent transverse rib.

10.4.3 Design for expansive soil conditions represents an extreme condition, therefore, it is permissible to multiply the usual ACI factored live plus dead load (1.4D + 1.7L) required strength by 0.75 when using strength design or use a one-third increase in allowable stresses for the service load design method.

10.5 **Prestressed Designs** - The above requirements also apply to prestressed ribbed mat foundations except as follows:

10.5.1 Slab reinforcement and rib top reinforcement may be deleted and replaced with post-tensioning strands. Mild steel (0.33 percent) shall still be provided in the bottom of ribs. Minimum prestress shall be 700 kPa (100 psi), including effects of subgrade friction as calculated by the PTI method, reference 2.2.17.

10.5.2 Section properties for calculation of bending stresses shall consider an effective flange for each rib as limited by ACI 318 for T-beams. Concrete tensile stress shall be limited to 3 multiplied by square root of f_c' and shear stress limited to 1.1 multiplied by square root of f_c'.

10.6 **Design Requirements for Family Housing**.

10.6.1 All design requirements of paragraph 10.2 through 10.5 apply to ribbed mat foundations for family housing, except as follows, and as shown on Plate S16.

10.6.2 Minimum rib width is 250mm, minimum depth is 500mm. Rib reinforcement shall be a minimum of 0.25 percent top and 0.25 percent bottom.

10.6.3 Minimum slab thickness is 100mm, with a minimum of 0.2 percent reinforcement. Capillary water barrier may be reduced to 100mm.

10.6.4 Analytical design may be by the CESWD method or by the PTI method. If post-tensioning is used, the criteria in paragraph 10.5 shall apply, except that minimum rib bottom steel may be 0.25 percent.

10.7 **Moisture control**. Controlling foundation moisture is critical for buildings on expansive soils, using ribbed mats. The structural designer should coordinate with the site designer and landscape design on the importance of measures to control water near the perimeter of the building.

10.7.1 All surface water flowing into the building site should be diverted around the structure so that it will not infiltrate the building subgrade.

10.7.2 Rainfall should be prevented from entering the ground near the perimeter of the structure, by providing paving where adequate drainage slopes are not possible and diverting gutter downspouts away from the foundation.

10.7.3 Wash-down floors should slope to drains to prevent water from entering the subgrade through joints in the floors.

10.7.4 When surface or underground water cannot be diverted away from the building, consider using interceptor or perimeter drains. Foundation drainage systems should be carefully designed to prevent them from introducing water to the foundation.

10.7.5 Landscape plantings and irrigation systems should be planned so that watering of beds or lawns does not introduce water to the building foundation and drying of the foundation due to withdrawal of water by roots from large plants near the building perimeter does not occur.

11. **<u>FIRST FLOOR DESIGN</u>**: Minimum design live and dead loads shall conform to criteria specified in the reference in TI 809-01 and ASCE 7. The design live load will be the larger of the minimum specified or the actual loads produced by the occupancy of the building.

11.1 **Slab-On-Grade Floors**. This is an economical floor system and should be used where the potential foundation movements are minor and there are not functional or esthetic reasons why movement will cause concerns. The Foundation Design Analysis may prohibit use of slab-on-grade floors when there are expansive soils unless some differential movement of the floor can be tolerated. Slab-on-grade floors may be used for buildings with light or heavy live loads and those subject to vehicular traffic (garages, shops, hangars, etc.). Administrative areas likely should not use slab-on-grade, because of esthetics, when small foundation movement is predicted.

11.1.1 <u>Slabs-on-grade</u> with light design loads (up to 1780 Pa (400 psf) or 22 kN (5 kip) fork-lift) should be designed in accordance with TI 809-02. Slabs subjected to heavy static or vehicular loads should be designed per reference TM 5-809-12.

11.1.2 <u>A "K" value</u> for use in designing slabs subject to vehicular traffic should be furnished by the Geotechnical Engineer. The "K" value is usually equal to or greater than 54300 kPa/m (200 psi/inch) due to the use of gravel and compacted, non-expansive fill under the floor slab.

11.1.3 <u>Slabs shall be a minimum of 100mm thick</u> with 0.1% reinforcing (for 7.5 meters joint spacing), except <u>in moderately expansive soils use minimums of 125mm thickness and 0.2% reinforcing</u>. Reinforcement shall be reinforcing bars or plain or deformed welded wire fabric. In tactical equipment shops interior slabs on grade will typically match the exterior hardstand pavement thickness with the addition of a minimum of 0.1 percent reinforcing steel. Aircraft hangar slabs will be designed using aircraft pavement criteria; the interior slab thickness will normally match the exterior pavement thickness with the addition of a minimum of 0.1 percent reinforcing steel.

11.1.4 <u>Joints for slabs-on-grade</u> should be shown on the contract drawings. Maximum joint spacing may range from 7.5 meters (0.1% reinforcement) to 15 meters (0.3% reinforcement), depending on slab reinforcing available for shrinkage cracking control. Slab reinforcement is discontinuous at joints. Use joint details shown on plates S21 and S22.

11.1.5 Provide a vapor barrier under all slabs-on-grade floors except for open warehouses, stoops, transformer pads, pavement, porches, etc. Vapor barriers may not be needed in arid regions with a deep water table.

11.1.6 Provide 150mm of capillary water barrier (gravel) under all building floor slabs-on-grade where slabs are above outside finished grade (basement slabs will not have gravel under them). Typically this requirement should be addressed in the Foundation Design Analysis.

11.1.7 Provide a 1.46 kg (30#) felt joint between floor slabs-on-grade and foundation beams and piers and other vertical surfaces which should be isolated from the slab.

11.1.8 Slabs-on-grade shall not bear on grade beams except where articulated pads are used.

11.1.9 Slabs-on-grade should be 21 Mpa (3000 psi) concrete. Slabs-on-grade subjected to vehicular loading should be designed using a minimum flexural strength in accordance with reference TM 5-809-12, (at Fort Polk the maximum flexural strength attainable from local concrete batch plants is 4.1 Mpa (600 psi).

11.1.10 Where interior columns occur, floor joints should be placed on column centerlines.

11.1.11 Slabs-on-grade with interior floor drains, such as mechanical rooms, will have a joint sealant placed on top of perimeter felt joint.

11.1.12 In washrack areas, joints should be eliminated by use of additional reinforcement to control shrinkage cracking. The joints between slab-on-grade and the foundation should have a joint sealant placed on top of the joint.

11.1.13 Topping over concrete slabs should be avoided, where possible. Where it must be used, topping should be a minimum of 50mm thick and reinforced with reinforcing bars or wire mesh in flat sheets.

11.1.14 In small areas surrounded by grade beams, such as entries, janitor's closets and corridors, where compaction of fill is hard to control, use a structural slab over a carton formed void.

11.1.15 In areas with ceramic or quarry tile or terrazzo floor finish, the floor should be structurally supported to minimize cracking of the floor finish. This is especially true where the walls or partitions surrounding the area are supported on grade beams. With a slab-on-grade floor, a 1.46 kg (#30) felt joint is normally provided between the slab and grade beams. Differential movement between the slab and the grade beam will result in cracking of the wall base and thereby create an unsightly and unsanitary joint at the base of the walls. As an alternate, small interior areas of tile or terrazzo finish surrounded by non-load bearing partitions may be placed on a turned-down-edge, or ribbed, slab isolated from the surrounding slab-on-grade floors by a 1.46 kg (#30) felt perimeter joint at the outside face of the partitions.

11.2 **Structurally Supported Floors**. Structurally supported first floors will be required in the following cases:

11.2.1 In expansive soils areas, the Foundation Design Analysis will usually recommend that the first floor be supported. Poured-in-place structural slabs and grade beams cast on carton forms or double tees supported by grade beams to form a minimum 150mm (6 inch) void are recommended systems. This 150mm (6 inch) void space does not have to be vented or provided with access and floor insulation. Bar joist or steel beam framing is not recommended since condensation in the unvented void space tends to cause corrosion.

11.2.2 In buildings where extensive, underfloor utility piping is required (such as hospitals, dental clinics, etc.), the using service will usually require that a vented, accessible crawl space be provided with a minimum of 460mm (18 inches) clearance below the lowest framing member. See crawl space criteria in the Architectural Chapter III. Since the crawl spaces are vented, underfloor insulation is required. Unless controlled by functional requirements, the selected framing system should be based on economy.

12. **UPPER FLOOR DESIGN**: Minimum design live and dead loads shall conform with criteria in the TI 809-01 and ASCE 7. The design live load will be the larger of the minimum and the actual loads produced by the occupancy of the building.

12.1 **System selection** should be based on economy unless functional or other considerations govern. Experience has shown that a system consisting of a structural concrete slab on stay-in-place corrugated metal forms supported by open web steel bar joists is often the most economical.

12.2 **Upper floors are used as diaphragms**, in most instances, to transmit lateral forces to shear walls or building frames. Design of diaphragms is covered in paragraph 18, below.

13. **STOOPS, RAMPS, AND PORCHES** Use details on enclosed Plates S32, S33, and S34. Large stoops, porches and main building entrance porches for dormitories, libraries, chapels, mess halls, etc., should be supported on foundations similar to the building foundation. Small stoops may be soil-supported, turned-down-edge type, slip-doweled to the building foundation.

14. **BASEMENTS**. Basement floors will be slab-on-grade separated from basement walls by 1.46 kg (30#) felt, except in expansive soil areas where a structural slab over a 150mm (6-inch) carton formed void may be required. Basement walls should have membrane waterproofing on the outside and under the slab with a continuous perimeter drain around basement. See details on enclosed Plates S35, S36, and S37. Basement walls must be designed for lateral hydrostatic pressure as well as lateral soil pressure. In such cases, the perimeter drains are usually assumed to be 50 percent effective; i.e., the water table in soil against the wall is assumed to be located at one-half the difference between the site design water table elevation and the elevation of the wall drain.

15. **WALLS AND PARTITIONS**:

15.1 **Lateral Loads**. Exterior walls must be designed to withstand wind and/or seismic lateral loads while spanning vertically from floor to floor (or roof) or horizontally between columns, pilasters or intersecting walls. The wall components design wind load will be determined from the worst possible combination of exterior and interior pressures (either inward or outward) and other provisions of criteria referenced in paragraph TI 809-02 and ASCE 7. Seismic loads for structural and architectural components will conform to criteria referenced in paragraph TI 809-04. Interior partitions must be designed to withstand a minimum lateral pressure of 240 Pa when using steel studs and 480 Pa for masonry walls or a lateral seismic load and spanned vertically or horizontally. If spanned vertically, partitions must be supported at the top by the roof or floor framing. Typical details for lateral support of metal stud partitions extending to bar joists is shown on plate S47 and for masonry walls on S42.

15.2 **Masonry Walls**: Plans for new construction in which the basic 100mm module is used for building lay-out are typically detailed with hard metric masonry. Concrete masonry units and clay brick manufactured to metric standards are not readily available. Soft metric CMU and brick, equivalent to standard I-P units, may be used by P.L. 104-289. Since this is common in CESWD this paragraph describes the soft metric design.

15.2.1 CMU and brick-CMU walls and partitions will be designed in accordance with TM 5-809-3 (future TI 809-06) or TI 809-04, as applicable.

15.2.2 Specify, and design for, type "S" mortar (F_m'= 9300kPa (1350 psi)).

15.2.3 Minimum Reinforcement. All masonry exterior, bearing and shear walls will be reinforced as specified in references given in paragraph 15.2.1. Unreinforced masonry structural walls will not be used. Where vertical reinforcement is required for CMU walls 255mm (10 inches), or less, in thickness use one reinforcing bar per grouted cell and place the bar in the center of cell. Use of two bars per grouted cell is not recommended in CMU less than 305mm (12 inches) thick due to the difficulty in obtaining proper reinforcement placement. Minimum seismic reinforcement details for use on facilities with a Seismic Design Category of C or higher are on plates S44, S45, and S46.

15.2.4 The use of 102mm (4-inch) CMU single wythe interior partitions and walls is not recommended. When vertical reinforcing is required the cells in 102mm (4-inch) CMU are too small to properly grout in a vertical reinforcing bar. Do not use 102mm (4-inch) CMU in seismic areas.

15.2.5 Double wythe brick-CMU exterior walls should be cavity walls with a 50mm minimum cavity to prevent moisture penetration. Due to moisture penetration CMU should not be used as an exterior wythe in cavity walls or as a veneer. Composite walls will not be used.

15.2.6 For cavity walls, if reinforcement is required and the outer wythe is brick (or 102mm (4-inch) CMU which cannot be reinforced), the inner wythe should be assumed to take the entire lateral load and should be reinforced accordingly.

15.2.7 Where roof or floor diaphragms are attached to bond beams which serve as the diaphragm chord, the bond beam reinforcement must be continuous across CMU control joints. If the wall is exposed to view, provide a "dummy joint" in the bond beam to match the control joint location.

15.2.8 Wall control joint locations and spacing and other crack control measures will be in accordance with references listed in paragraph 15.2.1, as applicable. Show control joint locations on architectural plans and elevations.

15.2.9 Vertical and horizontal reinforcement requirements for masonry walls must be clearly indicated on the structural or architectural drawings.

15.2.10 Masonry walls must be kept clear, 20mm minimum, of steel columns and soffit of steel beams. Also, attachments of masonry walls to building frames must be designed to allow independent movement in the plane of the wall and prevent shear wall action. Plates S41 and S42 show typical details.

15.3 **Steel Stud Walls and Partitions:** Light gage steel studs may be used for interior and exterior, load and non-load bearing, wall construction for most buildings. **See paragraphs 5.3.8 and 19.1 of this chapter for structural designer responsibility and design and detailing requirements.**

15.4 **Precast Concrete Walls.** Precast, site-cast (tilt up) or factory cast concrete, may be used for curtain walls or load-bearing shear walls.

15.4.1 PCI Design Handbook, "Precast and Prestressed Concrete," and PCA Engineering Bulletin, "Tilt-up Load Bearing Walls," may be used as design guides.

15.4.2 Special attention should be given to the need for slip-connections and/or additional reinforcement at connections to prevent or minimize cracking due to thermal expansion or contraction.

15.4.3 When curtain wall panels are connected to a building frame at two floor levels, design/detail the connections so the panel bears at only one level and receives only lateral support at the other level, to prevent load bearing/shear wall action.

15.4.4 For design in seismic zones, reference TI 809-4 and FEMA 302.

15.4.5 Precast panels will be designed for in-place loads similar to other building elements with the required steel reinforcing. The AE shall ether fully detail connections between the panels and the building framing or provide the in-place design loads on the plans for the contractor to use in selecting the connection. When the contractor is permitted to design and select the connection, responsibility for the connection shall remain with the engineer of record designer. Any additional reinforcing for shipping, transportation or erection is the responsibility of the panel supplier.

16. **BUILDING FRAMES**:

16.1 **General**. Systems with load bearing walls and shear walls are often more economical than complete building frames and should be considered in the selection process. The structural system shall be designed for both the vertical and horizontal loads required by the references in paragraphs TI 809-1, TI 809-4 or TI 909-5.

16.2 **Concrete Frames**:

16.2.1 Cast-in-place or precast concrete frames may be used as vertical-load-carrying or lateral-load carrying moment resisting frames with restrictions on their design for use in resisting seismic forces. Table 7-1 of TI 809-04 identifies the type of moment resisting concrete framing required for each Seismic Design Category. Use of precast seismic-force-resisting frames is permitted, provided the frame emulates the behavior of monolithic reinforced concrete construction or relies on demonstrated experimental evidence that seismic loading comparable to monolithic reinforced concrete is achieved. Complete documentation shall be submitted and approved by the supervising district when precast seismic-force-resisting framing is proposed for use.

16.2.2 Structural lightweight concrete may be used for floor systems but not in columns or beams.

16.2.3 Frame design will be in accordance with reference TI 809-4 and/or ACI 318, as applicable.

16.2.4 Provide expansion joints through concrete framed buildings at 75 meter on center, maximum.

16.2.5 Coordinate design with the applicable general notes on enclosed Plate S1.

16.3 **Steel Frames**:

16.3.1 Design will be in accordance with applicable AISC references listed in paragraph 2.2, TI 809-04, and SJI Standard Specifications, as applicable. Frame drift must be limited as necessary to prevent damage to supported wall systems and brittle cladding materials.

16.3.2 The framing plan should utilize braced frames, when practical, to carry lateral loads due to the economy of this system. When rigid frames are utilized to resist lateral loads, recommend that they consist of a combination of columns, which are rigidly connected to the beams, and columns with simple beam connections because of the high cost of using rigid connections at every joint. Assume the columns of both braced and rigid frames to be pin-connected at the foundation for design. The gravity only columns of both braced and rigid frames may be designed for an effective length equal to their actual length, ie. K = 1. Design of the columns with rigid connections to beams shall include second order effects. Second order effects consist of member effects and structure effects. When frames have a combination of rigidly and simply connected columns, the column effective length factor, K, for rigidly connected columns determined by the alignment chart nomograph in the commentary to the AISC Specifications does not account for the structure effects due to the simply connected columns. The reference in paragraph 2.2.28 presents several acceptable ways to account for the second order structure effects that may be used for this type of frame.

16.4 **STRUCTURAL STEEL CONNECTIONS**: Connection design shall be in accordance with applicable AISC Specifications referenced in paragraph 2.2, TI 809-04 and ER 1110-345-53. Structural steel connections may be classified under one of two categories, critical connections, or simple connections. Critical connections are those subjected to moment(s) and/or axial loads in combination with shear loads. Simple connections are connections subjected to shear only and are classified as shear connections. As required by ETL 1110-3-447, all critical structural steel connections shall be designed and completely detailed and shown on the contract drawings. When seismic controls the design of the main frame, fully restrained moment connections shall comply with requirements of TI 809-04. Neither construction contractors nor steel fabricators will be permitted to design critical steel connections. Simple connections shall also be detailed on the contract drawings unless the A-E scope of work specifically exempts detailing of these connections. In cases when allowed by the A-E scope of work, steel fabricators will be permitted to select and detail simple connection details (shear connections) from the AISC Manual of Steel Construction. When the steel fabricator is permitted to select and detail simple connections, responsibility for the connection's structural adequacy shall remain with the design engineer of record and the Contract Plans and Specifications shall require submission of these connections to the A-E for approval.

16.4.1 For one-story steel frame buildings bar joists or joist girders may be used in moment-resisting frames by extending the lower chord and attaching it to columns. The bottom chord connection will not be made until all of the roof dead load is in place. Calculations must be included in the design analysis to demonstrate adequacy of such construction.

16.4.2 Provide expansion joints through steel framed buildings at 90 meters on center maximum.

16.4.3 Trusses should be designed with web member arrangement such that members are symmetrically loaded in the plane of the truss.

16.4.5 See applicable superstructure notes on enclosed Plate S4.

17. **ROOFS**:

17.1 **General**: See Chapter III, Architectural, for requirements on roof slopes or any other criteria not covered below.

17.2 **Steel Roof Decks With Build-Up Or Single Ply Roofing**. The most commonly used (and usually most economical) low-slope roof system consists of build-up roofing or single ply roofing over rigid insulation over steel roof decking supported by steel bar joists. Where the roof framing supports a suspended ceiling, the bar joists are usually spaced at 1.2 meter o.c. in order to simplify the ceiling suspension system. Where sound attenuation is a design requirement or where a rigid diaphragm is needed, structural lightweight concrete may be placed over the steel deck. A minimum slope of 1 vertical to 48 horizontal should be provided for drainage. It is typically more economical to build this slope into the framing rather than using tapered insulation. Built-up roofing should not be used on slopes greater than 1 vertical on 4 horizontal. In designing steel roof decks, consideration should be given to the following:

17.2.1 For shear diaphragm design, see paragraph 18.1, below.

17.2.2 Minimum deck thickness is 0.85mm (22 ga) for shear diaphragm design.

17.2.3 See Superstructure Note 7, enclosed Plate S4.

17.2.4 Deck selection should include a consideration for construction and maintenance loads per the Steel Deck Institute specification.

17.3 **Concrete Roof Decks**:

17.3.1 Cast-in-place or precast concrete roof decks are acceptable; however, they are usually more costly than steel deck systems and are normally used only where required for fire proofing, sound attenuation or other special considerations.

17.3.2 Diaphragm design considerations are covered in paragraph 18.1 below.

17.4 **Pitched Roofs**.

17.4.1 Asphalt shingles, which are commonly used for roof slopes greater than 1 vertical on 4 horizontal, require a nailable deck for support. Since most military construction must be "protected, non-combustible" or "unprotected non-combustible", plywood decking or other types of wood decking are not usually used. Gypsum planks and so-called "nailable concrete" planks have been used in the past.

17.4.2 An alternative to asphalt shingles is structural standing seam metal roofing. See paragraph 17.5 below.

17.5 **Structural Standing Seam Metal Roof System (SSSMRS)**. SSMRS are composed of metal roof panels supported and/or attached by clips fastened directly to the building structure. The metal panels span between the structural supports to carry snow, dead, live, concentrated loads, and wind loads without additional support from other substrates that may be part of the roofing system. SSSMRS shall be specified through use of guide specification CEGS-07416 in specifications and details on the plans.

17.5.1 Past experience has shown that improperly designed, specified or installed metal roof systems have failed due to: panel buckling, panel sidelap seams (ribs) opening, anchor clips fracturing and fastener pull out, all due to wind uplift. For AE designed buildings, the roof framing system must be designed and detailed to show necessary structural framing members, prulins, or subpurlins to accommodate concealed anchor clip spacing**. Roof Panel Clip attachments to metal decks are not permitted.** The contract drawings will include loading diagrams/tables showing the design wind uplift pressures for all zones as determined by ASCE 7, including external and internal pressures. The contract drawings will also include minimum design live loads and or snow loading diagrams/tables where appropriate. Note: When the SSSMR system is a component of a metal building system, the loading criteria in CEGS 13120 Standard Metal Building Systems will apply.

17.5.2 During Selection of the building framing system it is necessary to consider the support requirements for the standing seam metal roof. See TI 809-29, Structural Considerations for Metal Roofing. The building frame members that support the SSSMR should be perpendicular to the roof slope. If the main structural roof framing system is parallel to the roof slope, then a solution that is compatible with most SSSMRS manufacturers is to provide Z-purlins perpendicular to and supported by and connected to the main framing system.

17.5.3 Steel Joist Institute criteria requires that top chords of joists be laterally supported. Some roofing systems, such as structural standing seam, do not have decks or attachments adequate to provide this support and do not have the structural properties necessary to act as a diaphragm; therefore, a supplementary bracing system is required.

18 SHEAR DIAPHRAGM DESIGN:

18.1 Steel Deck Diaphragms:

18.1.1 Steel deck diaphragms for both wind-controlled and seismic-controlled designs should be designed in accordance with SDI Diaphragm Design Manual. The designer should compute the maximum diaphragm shear in N/m (PLF) and select a satisfactory deck thickness (0.85mm (22 ga.), min.), type and pattern of connections from the tables in the Diaphragm Design Manual. Working stress allowable capacities from the Diaphragm Design Manual may be increased by 2.0 for use in strength design. In regions where seismic analysis controls design diaphragm shear, welded connections are required. Note that SDI does not recommend welded side lap connections with 0.85mm (22 gage) deck. This should be done for both 610mm (24 inch) wide panels and 915mm (36-inch) wide panels. The computed maximum shear and selected deck thicknesses and connections should be placed on the drawings (see Superstructure Note 7, Plate S4). It should be noted that the tables in the current Diaphragm Deign Manual, include 0.85mm, 1.0mm and 1.3mm (22, 20 and 18 ga.) thicknesses, only. Values for 1.6mm (16 ga.) and thicker decks will have to be computed from the formulas contained in the Diaphragm Design Manual. It will also be necessary to compute values for 1.3mm (18 ga.) deck for the commonly used roof deck span (joist spacing) of 1.2 meters.

18.1.2 Steel deck diaphragms usually fall in the flexible or semi-flexible category and, as such, will not distribute torsional forces (i.e., diaphragm shear reactions at shear walls or frames will be computed on a tributary area basis, only).

18.1.3 The lateral deflection of steel deck diaphragms which furnish lateral support for masonry walls should be checked against the allowable wall deflection. See Reference TM 5-809-3 for the computation of the allowable deflection for masonry walls. The actual maximum wall deflection is equal to the "story drift" that is the sum of the maximum diaphragm deflection and the average of the deflections of the frames or shear walls on either side of the diaphragm span.

18.1.4 Structural connections of the steel deck diaphragms to the building frame, sidelap connections, perimeter chords, connector plates at ridges, shear struts/collectors buildings to carry loads to shear walls and braced frames and other details for proper behavior of the diaphragm shall be fully designed by the AE and detailed on the contract plans.

18.2 **Precast Concrete Diaphragms**:

18.2.1 Design for both wind and seismic should be in accordance with reference 2.1.8.

18.2.2 Calculations must be included in the design analysis to demonstrate the adequacy of the side connections between neighboring precast elements to transmit shear and connection of the precast concrete diaphragms to the lateral force resisting building framing or shear walls.

18.3 **Shear Struts**:

18.3.1 One common error in design of shear diaphragms is the failure to provide struts where needed to allow uniform shear transfer from the diaphragm. Such cases arise where a shear wall or frame does not extend for the full depth of a diaphragm and at re-entrant corners of "L" and "T" shaped buildings. (In some cases, the floor or roof joist at that location may be sufficient to act as a strut.)

18.3.2 Struts must be designed for the horizontal compressive or tensile loads from the accumulated diaphragm shear as well as vertical loads from the diaphragms.

18.3.3 Connections between struts and shear walls or frames should be designed and detailed.

19. **SPECIAL DESIGN CONSIDERATIONS**:

19.1 **Use of Light Cold Formed Steel Framing.** Subject to design requirements referenced in the following paragraph, cold formed steel framing may be used as studs for interior and exterior walls as non-load bearing partitions and curtain walls carrying lateral loads or load-bearing systems that carry both lateral and vertical loads. Light gage steel framing may be used as joists or fabricated into trusses for support of vertical roof and floor loads.

19.1.1 TI 809-07 and AISI Specifications of The Design of Cold Formed Steel Structural Members will be used as design guidance and CEGS 05400, "Cold Formed Steel Framing" and CEGS 04220, "Non-bearing Masonry Veneer/Steel Stud Walls as the basis for contract specifications.

19.1.2 In accordance with reference TI 909-07 and CEGS 05400, the building structural designer has design responsibility for cold-formed steel systems and this responsibility will not be transferred to the Construction Contractor. The design analysis shall contain design calculations needed to size and for connections for cold formed framing. Contract Drawings shall completely detail the cold formed framing. **The structural designer is responsible for design and all details needed to implement the design for load carrying cold-formed framing system. Contract Plans and/or Specifications shall require all cold formed framing members and details that are not on the Contract Plans and are selected by the Construction Contractor to be submitted for review and approval by the structural designer**.

19.2 **Expansive Soil Areas**. Severe expansive soil conditions exist in the San Antonio area and portions of Fort Sill, Altus AFB, Sheppard AFB, and Fort Hood and in other known areas listed in TM 5-818-7. Design of buildings founded on expansive soil should be based on the criteria listed below. Where it is possible to found the building on a stable stratum such as gravel, rock or a sufficient thickness of compacted engineering fill, the criteria may be neglected.

19.2.1 Foundation. The Foundation Design Analysis (FDA) will indicate the type, or types, of foundation that can be used and will also indicate other special requirements such as carton-formed voids under grade beams and structurally supported first floors over a 150mm (6 inch) (minimum) void. The Foundation Design Analysis will also indicate any potential tensile forces caused by expansive soil, which may require additional vertical reinforcement in drilled piers. If the FDA indicates that the foundation material is expansive and these items are not covered in the FDA, the structural engineer should request guidance from the geotechnical engineer.

19.2.2 Framing. Due to the likelihood of differential movement, a primary consideration in framing selection is flexibility. Steel framing is preferred. Load bearing masonry or precast walls are acceptable, however, masonry walls should be made movement-tolerant by the use of closely spaced control joints. Cast-in-place concrete frames should be used only if a rigid foundation, such as a thick mat, is provided.

19.2.3 Exterior Walls. The flexibility requirement, mentioned above for frames, also applies to walls. Precast concrete panels or insulated metal panels will provide adequate flexibility. Brittle finishes such as stucco or brick veneer should not be used unless panelized by control joints. Long, unbroken runs of masonry should be avoided where possible. Where not possible, control joints should be provided at 5.5 meters o.c., maximum. These structural provisions need to be coordinated with Architectural details on plans.

19.2.4 Interior Partitions. Use metal stud, gypsum board, dry-wall construction where possible. Where brittle finishes must be used, liberal use of control joints is required. Coordinate with Architectural details on plans.

19.2.5 Basements. Basements, especially partial basements, should be avoided if at all possible. Where basements must be provided, the basement floors will be structurally supported over a 150mm (minimum) void; provide perimeter wall drains discharging to a sump; exterior faces of basement walls will be waterproofed. Lateral earth pressure (k) values and special excavation/backfill requirements will be cited in the Foundation Design Analysis. If this information is not available in the FDA, the structural engineer should request guidance from the geotechnical engineer.

19.2.6 Bench Marks. When benchmarks are required on building foundations (to monitor movement) use the detail on Plate S53.

19.2.7 Grading and Drainage. Care must be taken to ensure against ponding of water adjacent to the building foundation. These items should be coordinated with the civil site layout and landscape engineer. Some considerations are:

19.2.7.1 Grade sites to drain surface water well away from the building. This is particularly true for side-hill sites.

19.2.7.2 Do not use planters or shrubs which require frequent watering adjacent to buildings.

19.2.7.3 Areas subject to accidental spillage of water (air-conditioning cooling towers, etc.) should receive special attention to ensure discharge of spillage into storm drains or drainage away from the building.

19.2.8 Utilities. Special consideration should be given to connections, suspension and placement of under floor utility lines to prevent damage due to soil heave. Testing should be done immediately before final acceptance of the building to detect leaks due to disturbance during construction. Roof drains should be carried down the outside of exterior walls where possible. Sewer, water and drain lines in crawl spaces shall be supported clear of the crawl space floor utilizing trenches if necessary. The Foundation Design Analysis will indicate whether special provisions must be made for under floor utilities. In such cases, the mechanical design engineer should be contacted for guidance.

19.3 **Special Concrete Requirements.** To alleviate deterioration of concrete due to sulfate action at White Sands Missile Range, the following requirements should be required by the contract specifications. The AE should contact the supervising district Technical Coordinator for a copy of special concrete specifications. For all concrete used in foundation construction: (a) coarse and fine aggregates will be washed, (b) calcium chloride or admixtures containing chloride salts will not be used, (c) all concrete will have air entrainment. In addition for all concrete less than 600 mm above finished grade, except for floor slabs within buildings and for concrete used for electrical systems (ducts, manholes, pull boxes, vaults, etc.) will: (a) use Type V cement, (b) have an air content by volume of 5.5 percent plus or minus 1.5 percent, (c) contain an approved type F pozzolan, (d) contain not less than 400kg of cement per cubic meter of concrete (675 lb. (seven sacks) of cement per cubic yard of concrete), (e) not exceed a slump of 75 mm (f) be moist cured for 10 days, and (g) receive a water proofing surface treatment consisting of two coats of linseed oil.

19.4 **Seismic Provisions**. The basic seismic design criteria is contained in reference given in TI 809-04 and FEMA 302 and will be followed subject to the exceptions and clarifications listed below:

19.4.1 The Spectrical Accelerations S_s and S_1 for each base in the Southwestern Division are listed in paragraph 22. Also provided in paragraph 23 and 23.1 is guidance for bases in low seismically areas where seismic analysis does not need to be performed because lateral wind loading will control design.

19.4.2 The design examples contained , in reference given in TI 809-04 appendix H, should be used as guides for presenting the seismic design analysis. See Chapter IX; Design Analysis Chapter 4 for additional guidance on seismic analysis.

19.4.3 Minimum seismic reinforcement must be provided for CMU walls in facilities with a Seismic Design Category of C and higher. This requirement increases the cost of CMU walls making other wall systems more competitive. This should be kept in mind in making wall system selection.

19.5 **Fallout Shelter Spaces**. Addition of fallout shelter spaces may be requested by the using agency as part of a project design. Unless provisions of shelter spaces are included in the programmed amount for a facility, the cost limitation on any special construction measures is 1 percent of the programmed amount. PF 40 provides protection from fallout radiation for basic life safety for a 14 day period while radiation is life threatening. PF 100 is appropriate only for essential facilities which must continue to function during a radiation emergency. Analysis and design of shelter spaces will be in accordance with the current standards published by the Defense Civil Preparedness Agency. For additional information refer to the reference given in paragraph 2.1.19.

19.6 **Aircraft Hangar Wind Loads**. Southwestern Division policy is to design aircraft hangar and maintenance buildings to resist wind loads resulting from the basic wind speed set forth in reference TI 809-01 with aircraft access doors both open and closed. Deviation from this policy will require a waiver from MACOM or MAJCOM.

19.7 **Monorail Design**. Hoist runway beams and their supporting hangers shall be designed and detailed by the design engineer. Beam design shall be conservative due to the possibility of overloads caused by misuse of the hoist. The criteria given herein is for design of monorails supporting hoists with rated capacity of 8.9 kN (2000 pounds), or smaller.

19.7.1 Except as specified herein, the monorail beam design shall be in accordance with AISC deign specifications taking into account the laterally unsupported length of the beam compression flange. The monorail beam vertical service live load shall be 1.5 times the rated capacity of the hoist, to account for impact and overload, and a lateral load of 0.2 times the hoist rated capacity perpendicular to the beam. The beam shall be designed for the service live load plus dead load of beam and hoist. The vertical beam deflection to length ratio shall be limited to 1/800 with a service live load equal to the rated hoist capacity. An “S shape” beam with channel on top should be used for all but very short spans.

19.7.2 The service live load for hangers supporting the monorail beam shall be 2.0 times the rated capacity of the hoist and a lateral load of 0.2 times the rated hoist capacity perpendicular to the beam. The hangers shall be designed for the service live load plus dead load of the beam and hoist. Monorail beams should be braced for longitudinal forces equal to 0.1 times the rated hoist capacity. Instead of using longitudinal beam bracing, the longitudinal force may be carried by designing the hangers for this longitudinal force in addition to the loads described above.

19.7.3 One load case for design of the building framing supporting the monorail shall be vertical service design load of 1.5 times the rated capacity of the hoist combined with all other live loads and dead loads supported by the framing.

When the monorail is supported by roof framing, a service live loads of 0.5 times the total roof design live load is appropriate for combining with the hoist service load of 1.5 times the hoist rated capacity. When building framing supporting the monorail is open web steel joists, the design engineer shall designate KCS joists or provide a load diagram for custom design by the joist manufacturer. The design shall also assure proper joist loading due to the concentrated loads at the monorail hangers by requiring the hangers to be at the panel points, or adding special joist web or cord reinforcing when the hangers are not at the panel points.

19.8 **Traveling Crane Runway Girders**. Runway girders may be designed as simple or continuous members with certain limitations. Continuous girders should not be used where significant unequal foundation settlement is likely to occur. Where foundations are other than shale or hard rock, check anticipated differential settlement so that the difference is limited to 0.003 L between adjacent supports. Limit live load deflection to span length at mid-span to 1/800. The flanges of crane girders shall be proportioned to resist AISC code lateral forces. For continuous girders limit ratio of length of adjacent spans to 2:1. Connect ends of simply supported girders in such a manner as to allow the ends to rotate under vertical loading. Use adjustable bolted connections for fastening the rail to the girder (welded connections are not permitted).

19.9 **Firewalls.** Fire codes require that 4-hour rated firewalls be self supporting (free standing) and cannot be attached to the building framing on either side for top support unless the framing has a 1-1/2 hour fire rating. If it is not feasible to cantilever a single firewall from the foundation, a double wall may be used with each wall attached to, and supported by, the adjacent building framing. The foundations for such walls must, of course, be designed for the imposed loads. The minimum lateral design load for fire-walls should be 480 Pa unless a portion of the wall is exposed to exterior wind loads. Fire rated walls with less than a 4-hour fire rating (sometimes called "fire partitions") need not be free standing and may be supported by the building framing. Control joints in firewalls should be keyed and caulked with rock wool held in place by mortar (applies to both faces).

19.10 **Antiterrorism/Force Protection.** Security engineering is an important aspect of facility design. Structural measures due to force protection requirements may require the design of the framing system, wall type and thickness, and structural roof system to form a protective system. DD Form 1391 establishes aggressor tactics and level of protective design and the security engineering associated costs for the project. Project development for the DD 1391 should follow the guidance in TM 5-853-1. Guidance for preparation of the concept design is in TM 5-853-2 and for the final design in TM 5-809-3. Coordination between the facility Architectural designer and structural design engineer is needed early during the lay-out of the building when blast resistant construction is required.

20. MISCELLANEOUS STRUCTURES:

20.1 **Manholes, Pullboxes, Surface Inlets, etc.** These structures should comply with details shown in Chapter II, Civil and Chapter VI, Electrical. Concrete strength will be 21 mPa (3000 psi) unless otherwise shown. Precast concrete structures are acceptable and should be used where more economical. H10 design wheel loads will be used except that structures in pavement will be designed for the pavement design wheel loads.

20.2 **Headwalls**. Dimensions of headwalls should be similar to those shown on plates in Chapter II, Civil. Concrete strength will be 21 mPa (3000psi) unless otherwise shown. Keyed construction joints should not be used.

20.3 **Transformer Pads and Condenser Pads**. See Plate S59 for typical structural details. Concrete should be 21 mPa (3000 psi).

20.4 **Retaining Walls and Other Earth Retaining Structures**. Guidance for the design of retaining structures is furnished in EM 1110-2-2501, Retaining and Flood Walls. Lateral earth loads on structures should be based on p = whk where p = lateral pressure, w = wet unit weight of earth 585kg/m^2 (120 pcf) minimum, may be higher in some areas, h = depth of soil and k = coefficient of lateral earth pressure which will be furnished in the Foundation Design Analysis or by geotechnical engineer. Surcharge loads should be included where applicable. In case of high ground water table, investigation should also be made for lateral buoyant earth pressure plus 100 percent hydrostatic pressure at one-third overstress. Where drains or weep holes are provided (see Plate S60), the water table may be assumed to be lowered 50 percent of the difference in the water table and drain elevations. Hydrostatic uplift should also be included. It is considered acceptable practice to design retaining walls for the following criteria:

20.4.1 The resultant of the vertical and horizontal loads falls within the middle third of the base.

20.4.2 The bearing pressure must not exceed the allowable bearing pressure.

20.4.3 The safety factor against overturning must be at least 1.5.

20.4.4 The sliding safety factor must be at least 1.5. Where a sloping backfill surface occurs, the Geotechnical Engineer should be contacted for adjustment of the design "K" lateral earth pressure factor. It is preferred that the working stress method of design be used with actual (unfactored) loads.

20.5 **Metal Buildings Systems.** Off-the-shelf or custom designed pre-engineered metal buildings are economical and suited to some projects such as shops, small storage or equipment buildings, etc. Use of these buildings should be considered where permitted (or specified) by the using service. Economy is fully realized when all components of the pre-engineered building are utilized, i.e., steel framing, purlins, girts, metal roof, and wall panels. When substitutions are made for any of these basic components, the savings will be reduced. Pre-engineered metal buildings are not recommended when the building geometry and/or architecture is not compatible with the use of continuous frames consisting of fabricated tapered columns and rafters. The following considerations apply:

20.5.1 Foundations and floors should be detailed on the construction drawings.

20.5.2 The building supplier should be allowed minor variations in building dimensions to accommodate off-the-shelf designs.

20.5.3 All loads required for design of the building frames should be specified including wind, seismic and crane loads.

20.5.4 Place applicable pre-engineered building notes from enclosed Plate S5 on the construction drawings. The Engineer of Record shall approve the structural design analysis prepared by the pre-engineered building manufacturer.

20.6 **Storage Tank Foundations.** Foundations for storage tanks shall conform with recommendations in the Foundation Design Analysis, tank manufacturers recommendations, API 640, Welded Steel Tanks for Oil Storage, and minimum requirements shown on Plates S56, S57, and S58.

20.6.1 The width of reinforced concrete ring foundations for vertical tanks on ground shall be designed to support the load from the tank wall and roof plus weight of tank fluid directly above the ring without exceeding the allowable foundation bearing pressure. The ring circumferential reinforcement shall be designed for hoop tension caused by "at rest" lateral earth pressure acting on the inside of the ring, taking into account the surcharge from weight of fluid in the tank. When applicable, the ring shall be designed for stresses resulting from seismic forces combined with the other stresses. See API Standard 650, Welded Steel Tanks for Oil Storage, for seismic forces on tanks.

20.6.2 Foundations for elevated tanks shall be designed for most unfavorable combination from weight of tank, weight of tank contents, and effects from lateral forces due to wind and earthquake.

20.7 **Reinforced Box Culverts.** Box culvert design shall conform to the requirements in AASHTO Standard Specifications for Highway Bridges. Appropriate State Highway Department standard designs that conform to AASHTO specifications may be used.

21. **ENGINEER-OF-RECORD.** The Engineer-of-Record (EOR) for all aspects of structural designs, including connections, for in-house jobs shall be the Chief of the engineering office performing the design. The EOR for all aspects of structural designs, including connections, for Architect-Engineer or Engineer-Architect designs, shall be the principal-in-charge of the design firm. ETL 1110-3-447 sets a policy that the design of structural steel (except for metal building systems), reinforced concrete, precast concrete framing and cladding and their connections (except precast lifting design), and masonry the project designer shall maintain complete design responsibility for members and connections, and not transfer this responsibility to the Construction Contractor. In a like manner TI 5-809-07 and provisions of CEGS 05400 require the project designer to have ultimate design responsibility for design of light gage cold-formed framing.

22.

Basic Wind Speeds, Seismic Spectral Accelerations, Ground Snow Loads

LOCATION	(Note 1) BASIC WIND SPEED Km/hr	(MPH)	(Note 2) SEISMIC ACCELERATIONS S_s g	S_1 g	(Note 3) GROUND SNOW LOAD N/m^2	(PSF)
Altus AFB, OK	145	(90)	0.18	0.06	480	(10)
Amarillo, TX (Pantex)	145	(90)	0.16	0.04	720	(15)
Brooks AFB, TX	145	(90)	0.13	0.04	240	(5)
Dyess AFB, TX	145	(90)	0.08	0.03	720	(15)
Fort Chaffee AR, OK	145	(90)	0.20	0.10	480	(10)
Fort Bliss, TX	145	(90)	0.35	0.10	480	(10)
Fort Hood, TX	145	(90)	0.09	0.05	240	(5)
Fort Polk, LA	165	(100)	0.15	0.07	240	(5)
Fort Sam Houston, TX	145	(90)	0.12	0.04	240	(5)
Fort Sill, OK	145	(90)	0.35	0.09	480	(10)
Goodfellow AFB, TX	145	(95)	0.08	0.03	240	(5)
Kelly AFB, TX	145	(90)	0.13	0.04	240	(5)
Lackland AFB, TX	145	(90)	0.13	0.04	240	(5)
Laughlin AFB, TX	145	(90)	0.08	0.03	0	(0)
Little Rock AFB, AR	145	(90)	0.53	0.19	480	(10)
Lone Star AAP, TX	145	(90)	0.18	0.08	240	(5)
Longhorn AAP, TX	145	(90)	0.18	0.07	240	(5)
Louisiana AAP, LA	145	(90)	0.19	0.09	240	(5)
McAlester AAP, OK	145	(90)	0.20	0.09	480	(10)
Pine Bluff Arsenal, AR	145	(90)	0.42	0.17	480	(10)
Randolph AFB, TX	145	(90)	0.12	0.04	240	(5)
Red River AAP, TX	145	(90)	0.19	0.09	240	(5)
Reese AFB, TX	145	(90)	0.09	0.03	960	(20)
Sacramento Peak, NM	195	(120)*	0.35	0.10	2400	(50)
Sheppard AFB, TX	145	(90)	0.17	0.06	240	(5)
Tinker AFB, OK	145	(90)	0.30	0.09	480	(10)
Vance AFB, OK	145	(90)	0.20	0.07	480	(10)
White Sands, NM (main post only)	145	(90)	0.40	0.10	240	(5)

See notes on following page.

Notes for Wind Speed, Seismic Accelerations, and Snow Load table.

(1) Site specific wind speeds are form TI 809-01. Basic wind speed are 50-year recurrence interval, 3-second gust speed. Design wind pressure should be determined using ASCE 7. (*) indicates special wind region.

(2) Seismic accelerations are based on mapped contours from the National Seismic Hazard Study by the U.S. Geological Survey for the Federal Emergency management Agency. S_s is Spectral Acceleration at 0.2 seconds. S_1 is Spectral Acceleration at 1.0 seconds. Seismic design shall conform with TI 809-04.

(3) Ground snow loads are from TI 809-01. Snow loads on roofs will be in accordance with TI-809-01. The minimum roof Live load of 960 N/m^2 (20 psf) will be satisfactory except when roof slopes can cause drifts and ground snow loads are 720 N/m^2 (15 psf) or more.

23. **Seismic Design Analysis Design Aid**. The Seismic Spectral Accelerations within the Southwestern Division military boundaries are generally low to moderate. Therefore, design for wind loads instead of seismic design analysis requirements will control the required strength of the primary lateral force resisting structural system and other components for many facilities. The Seismic Design Category table that follows in paragraph 23.1 provides the seismic Design Category for each of the three building Seismic Use Groups for each military installation located within CESWD. The Design Categories where determined using the TI 809-04 provisions using the base Seismic Spectral Accelerations listed in paragraph 22 above, and Site Classifications for the base that are listed in the table below. The Site Classifications where based on the general soil properties at each military installation. The Seismic Design Category values where obtained by computing the design spectral response acceleration values, S_{DS} and S_{D1}, at each base for each Seismic Use Group and these where used to select the Seismic Design Category from the TI tables 4-2a and 4-2b. The tabulation may be used to indicate that seismic loading will not control the design of the main lateral force resisting system. Within CESWD no additional seismic analysis is required for the design of the main lateral force resisting system for the facility when the Design Category tabulated below is A or B.

However, all parts of the structure between separation joints shall be interconnected to form a continuous load path and concrete or masonry walls shall be anchored to roof and floors and other members that provide lateral support for the wall or which are supported by the wall. When the Seismic Design Category tabulated is C or higher, a seismic analysis of the lateral force resisting system should be performed. The requirements for basic seismic force resisting structural systems and components required in Chapter 7 of the TI shall be complied with for facilities with Design Categories of C or higher, even for those where seismic loading does not control the design of the lateral force resisting system.

23.1

Seismic Design Category
Design Aid

Location	Site Class (Note 1)	Seismic Use Group (Note 2) I	II	III
Altus AFB, OK	C	A	A	A
Amarillo, TX (Pantex)	D	B	B	C
Brooks AFB, TX	Note 3	A	A	A
Dyess AFB, TX	Note 3	A	A	A
Fort Chaffee AR, OK	C	B	B	C
Fort Bliss, TX	D	C	C	D
Fort Hood, TX	D	B	B	C
Fort Polk, LA	D	B	B	C
Fort Sam Houston, TX	Note 3	A	A	A
Fort Sill, OK	D	C	C	D
Goodfellow AFB, TX	Note 3	A	A	A
Kelley AFB, TX	Note 3	A	A	A
Lackland AFB, TX	Note 3	A	A	A
Laughlin AFB, TX	Note 3	A	A	A
Little Rock AFB, AR	C	C	C	D
Lone Star AAP, AR	D	B	B	D
Longhorn AAP, TX	D	B	B	C
Louisiana AAP, LA	D	C	C	D
McAlester AAP, OK	D	C	C	D
Pine Bluff Arsenal, AR	E	D	D	D
Randolph AFB, TX	Note 3	A	A	A
Red River AAP, TX	D	C	C	D
Reese AFB, TX	Note 3	A	A	A
Sacramento Peak, NM	Note 4	-	-	-
Sheppard AFB, TX	C	B	B	C
Tinker AFB, OK	D	C	C	D
Vance AFB, OK	D	B	B	C
White Sands, NM (main post only)	D	C	C	D

See notes on following page.

Notes for Seismic Design Category - Design Aid table.

No additional seismic analysis is required for the design of the main lateral force resisting system of the facility when its tabulated Design Category is A or B. When its Seismic Design Category is C or higher, a seismic analysis should be performed.

The Design Categories where determined using the TI 809-04 provisions using the base Seismic Spectral Accelerations listed in paragraph 22, and Site Classifications for the base that are listed in the table. The Site Classifications where based on the general soil properties at each military installation. The Seismic Design Category values where obtained by computing the design spectral response acceleration values, S_{DS} and S_{D1}, at each base for each Seismic Use Group and these where used to select the Seismic Design Category from the TI tables 4-2a and 4-2b

(1) See TI 809-04 Table 3-1 for definition of Site Classification.

(2) See TI 809-04 Table 4-1 for selection of the facility Seismic Use Group based on occupancy or function.

(3) Structures located in regions having short period spectral response values, $S_{s,}$ less or equal to 0.15g and values of the 1 second period spectral response acceleration, S_1, less than or equal to 0.04g are permitted to be directly categorized as Seismic Design Category A.

(4) Site Classifications on Sacramento Peak are variable and facilities constructed are typically unoccupied. Designer should select appropriate seismic determinations for design.

APPENDIX A

Plates

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Plate	General Information
S1	General Notes
S1A	General Notes Continued
S2	Foundation Notes (Slab-on-Grade)
S3	Foundation Notes (Ribbed-Mat Slab)
S4	Steel Framing Notes
S5	Pre-Engineered Building Notes
S6	Not used
	Reinforcement Lap, Embedment and Cover
S7	Not used
S8	Table A - Reinforcement Tension Laps, and Embedment
S8A	Notes for Table A
S9	Not used
S10	Table B - Concrete Cover
	Pier and Beam Foundation Details
S11	Typical Pier and Column Details
S12	Typical Corner & Intersection Reinforcing
S13	Typical Grade Beam Reinforcing Diagram
S14	Typical Grade Beam Void Details
	Ribbed-Mat Foundation Details
S15	Partial Plan - Frame Construction
S16	Ribbed Mat Foundation Sections
S17	Optional Details of Exterior Beams
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S20	Typical Exterior & Interior Grade Beam
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S22	Weakened Plane Joint Details
S23	Engine Generator & Equipment Pads
S24	Typical Floor Trench Details

Index (cont.)

Index (cont.)

GENERAL NOTES:

1. DESIGN LIVE LOADS - TI 809-01 & ASCE 7

ROOF - _______ Pa

FLOORS:
FIRST -________ Pa
UPPER - ________ Pa
MECHANICAL - - - - - - - - - - - - - - - - - - -________ Pa
(Corridors, Stairs, Others) - - - - - - - - - - -________ Pa

2. WIND LOAD PARAMETERS - TI 809-01 & ASCE 7
BASIC WIND SPEED - - - - - - - - - - ______________Km/h
IMPORTANCE FACTOR - - - - - - - - - -_____________
EXPOSURE CATEGORY - - - - - - - - _____________

3. SEISMIC DESIGN PARAMETERS - TI 809-04 & FEMA 302
SEISMIC SPECTRAL ACCELERATIONS
S_s - - - - - - - - - - - - - - - - - - -_______________g
S_1 - - - - - - - - - - - - - - - - - - -_______________g
SEISMIC USE GROUP - - - - - - - - - - - -______________
SEISMIC DESIGN CATAGORY - - - - - - - ______________
(Add the following when the Seismic Design Catagory is C or higher)
DESIGN SPECTRAL ACCELERATIONS
S_{DS} - - - - - - - - - - - - - - - - - _____________g
S_{D1} - - - - - - - - - - - - - - - - - _______________g
RESPONSE MODIFICATION FACTOR FOR
BASIC SEISMIC FORCE RESISTING SYSTEM
R - _____________

4. GENERAL CONCRETE NOTES:

CONCRETE FOR BUILDING MEMBERS SHALL HAVE A SPECIFIED COMPRESSIVE STRENGTH OF 21 Mpa (3000 psi), UNLESS OTHERWISE NOTED.

CONCRETE FOR SLABS SUBJECTED TO VEHICULAR WHEEL LOADS SHALL HAVE A SPECIFIED COMPRESSIVE STRENGTH OF 28 Mpa (4000 psi).

NONPRESTRESSED CONCRETE REINFORCEMENT SHALL CONFORM WITH ASTM A 615/615M GRADE 60/420.

REINFORCEMENT LAP SPLICES AND EMBEDMENT LENGTHS SHALL CONFORM TO TABLE A, CLASS B, CASE 2 LENGTHS SHOWN ON DWG _____.
(Designer: See Plate S8 for Table A)

CONCRETE COVER OVER REINFORCEMENT SHALL CONFORM TO THE MINIMUMS REQUIRED BY TABLE B ON DWG. ______. (Designer: See Plate S10 for Table B)

REINFORCEMENT DETAILING AND PLACEMENT SHALL CONFORM TO ACI 318 AND ACI 315.

(See Plate S1A for continuation of GENERAL NOTES)

NOTE TO DESIGNER:

MODIFY NOTES AS REQUIRED WHEN DESIGN CONCRETE STRENGTH IS NOT IN ACCORDANCE WITH GNERERAL NOTE 4. STRUCTURAL DETAILS SHOULD SHOW CONCRETE REINFORCEMENT COVER, LAPS AND EMBEDEMENTS AND CONSTRUCTION JOINT LOCATIONS THAT DO NOT CONFORM TO NOTE 4.

GENERAL NOTES CONTUNUED FROM PLATE S1

CONSTRUCTION JOINTS IN BEAMS ANS SUPPORTED FLOOR SLABS NOT SHOWN ON DRAWINGS SHALL BE PLACED THE CENTER OF A SPAN, WITH JOINT SPACING NOT TO EXCEED 18 m.

SEE FOUNDADITION NOTES (SLAB-ON-GRADE) OR (RIBBED MAT SLAB) FOR THEIR CONSTRUCTION JOINT REQUIREMENTS.

MECHANICAL EQUIPMENT PADS ON FLOOR SLABS SHALL BE 100 MM THICK AND REINFORCED WITH #10 @ 300 mm EW., UNLESS OTHERWISE SHOWN.

5. GENERAL CONCRETE MASONRY NOTES:

HOLLOW CMU UNITS SHALL CONFORM TO ASTM C9 90 TYPE 1. OF THE NOMINAL THICKNESS SHOWN ON THE DRAWINGS.

MORTAR FOR CMU SHALL CONFORM TO ASTM C 270, TYPE S UNLESS OTHERWISE NOTED.

GROUT FOR CMU GROUTED CELLS, LINTELS, COLUMNS, PILASTERS, BOND BEAMS AND BLOCKS WITH EMBEDDED ANCHORS SHALL CONFORM TO ASTM C 476 WITH A MINIMUM COMPRESSIVE STRENGTH OF 14 Mpa (2000psi), UNLESS OTHERWISE NOTED.

CONTROL JOINTS SHALL BE OF THE TYPE AND AT THE LOCATIONS SHOWN ON THE DWGs.

CMU REINFORCING BARS SHALL CONFORM TO ASTM A 615/615M GRADE 60/420. JOINT REINFORCEMENT SHALL BE COLD DRAWN WIRE WITH A MINIMUM OF 9 GAUGE LONGITUDINAL WIRE SIZE, UNLESS OTHERWISE NOTED, WITH THE TYPE AND SPACING AS SHOWN ON THE DWGs OR SPECIFIED.

TENSION AND COMPRESSION LAP SPLICE LENGTH SHALL BE 48 TIMES THE DIAMETER OF THE BAR.

6. SUBSTITUTION OF EXPANSION OR DRILLED AND GROUTED-IN ANCHORS FOR EMBEDDED ANCHORS SHOWN ON THE DRAWINGS WILL NOT BE PERMITTED.

7. THE STRUCTURE SHOULD NOT BE CONSIDERED TO BE STABLE DURING CONSTRUCTION UNTIL ALL ELEMENTS ARE IN PLACE AND CONNECTED. THE CONTRACTOR IS RESPONSIBLE FOR ALL TEMPORARY CONSTRUCTION BRACING REQIRED.

NOTE TO DESIGNER:

DELETE NOTE 5 WHEN NO CMU WILL BE USED FOR CONSTRUCTION

EXPANSION OR DRILLED AND GROUTED-IN ANCHORS SHOULD ONLY BE USED FOR CONNECTIONS OF NEW CONSTRUCTION TO EXISTING FACILITIES

FOUNDATION NOTES: (SLAB - ON - GRADE)

1. DESIGN FOUNDATION BEARING PRESSURE (NET)____ kPa.

2. DRILLED PIERS SHALL EXTEND APPROXIMATELY______ m BELOW EXISTING GRADE INTO ______. THE ACTUAL DEPTH, SHALL BE DETERMINED IN THE FIELD BY THE CONTRACTING OFFICER.

3. PLACE 150 mm CAPILLARY WATER BARRIER AND VAPOR BARRIER UNDER ALL NON-STRUCTURAL FLOOR SLABS ON FILL. EXCEPT AS OTHERWISE NOTED.

4. REINFORCEMENT SHALL BE PLACED 40 mm FROM TOP OF NON-STRUCTURAL SLABS ON GRADE, UNLESS OTHERWISE NOTED.

5. FLOOR SLAB CONSTRUCTION JOINTS (C. J.) SHALL BE PLACED AS SHOWN ON FOUNDATION PLANS.

6. FLOOR SLAB ISOLATION JOINTS SHALL BE 1.46 kg (30#) FELT, UNLESS OTHERWISE NOTED.

7. FOR CONSTRUCTION JOINT AND WEAKENED PLANE JOINT DETAILS. SEE SHEET_____ OF_____ .

8. CONCRETE FLOOR SLAB ON GRADE MAY BE PLACED IN LANES. SPACING OF JOINTS SHALL BE AS SHOWN ON THE FOUNDATION PLAN. WHEN LANE PLACEMENT IS USED, CONSTRUCTION JOINTS SHALL BE USED FOR THE JOINTS BETWEEN LANES. SAW CUT WEAKENED PLANE JOINTS SHALL BE PROVIDED ACROSS EACH LANE AT SPACING SHOWN ON PLANS.

9. ALL EXTERIOR GRADE BEAMS SHALL BE CHAMFERED 15mm ON THE EXTERIOR EXPOSED CORNER.

10. FILL:

    A. ALL FILL PLACED UNDER BUILDING SLABS SHALL BE COMPACTED TO NOT LESS THAN 92 % MAX. DENSITY ACCORDING TO ASTM D 1557.

    B. REMOVE______ OF EXISTING MATERIAL AND REPLACE WITH NON - EXPANSIVE FILL UNDER THE 150 mm CAPILLARY WATER BARRIER.

11. ALL GRADE BEAMS SUPPORTED BY DRILLED PIERS OR PILES SHALL HAVE VOIDS UNDER THEM. (SEE DETAILS)

NOTE TO DESIGNER:

DELETE NOTE 11, WHEN NOT REQUIRED BY THE FOUNDATION DESIGN ANALYSIS.

FOUNDATION NOTES: (RIBBED MAT SLAB)

1. DESIGN FOUNDATION BEARING PRESSURE (NET) _______ kPa.

2. PLACE 150 mm CAPILLARY WATER BARRIER AND VAPOR BARRIER UNDER ALL SLABS. EXCEPT AS OTHERWISE NOTED.

3. CONSTRUCTION JOINTS (C. J.) SHALL BE PLACED IN LANES THRU SLABS AND BEAMS AND SAW CUT JOINTS IN SLABS PERPENDICULAR TO THE LANES AT THE SPACING SHOWN ON THE FOUNDATION PLAN.

4. CONCRETE CLEAR COVER OVER SLAB REINFORCEMENT SHALL BE 40 mm ≤ T/4 ≤ 65 mm FROM THE TOP OF THE SLAB UNLESS OTHERWISE NOTED. (T = SLAB THICKNESS)

5. FILL:

   A. ALL FILL PLACED UNDER BUILDING SLABS SHALL BE NON-EXPANSIVE AND SHALLL BE COMPACTED TO NOT LESS THAN 92 % MAXIMUM DENSITY ACCORDING TO ASTM D 1557, METHOD D.

   B. REMOVE _____________ OF EXISTING MATERIAL AND REPLACE WITH NON-EXPANSIVE FILL UNDER THE 150 mm CAPILLARY WATER BARRIER.

STEEL FRAMING NOTES

1. UNLESS OTHERWISE SPECIFIED, HOT- ROLLED STEEL BUILDING MEMBERS USING W-SHAPES SHALL BE ASTM A992 OR A572 GRADE 50 WITH AISC TECHNICAL BULLETIN * 3 SPECIAL REQUIREMENTS, M-, S-, AND CHANNEL SHAPES ASTM A572 GRADE 50, SQUARE, RECTANGULAR & ROUND HSS SHAPES ASTM A 500 GRADE C, ANGLES AND MISSACELENOUS STIFFNER PLATES ASTM A 36.

2. ALL SHEAR CONNECTIONS NOT DETAILED OR OTHERWISE NOTED SHALL BE STANDARD AISC WELDED OR AISC BOLTED CONNECTIONS AND SHALL HAVE SUFFFICIENT CAPACITY TO SUPPORT (THE END REACTION SHOWN ON THE DRAWING) OR (THE END REACTIONEQUAL TO ONE - HALF THE TOTAL UNIFORM LOAD CAPACITY SHOWN IN THE ALLOWABLE UNIFORM LOAD TABLES IN PART 2 OF THE AISC ALLOWABLE STRESS DESIGN MANUAL).

3. WELDING SHALL CONFORM WITH AWS D1.1 STRUCTURAL WELDING CODE.

4. ALL BOLTS FOR BEAM CONNECTIONS SHALL BE ASTM A325M WITH A MINIMUM DEAMETER OF 16 mm. UNLESS OTHERWISE NOTED. ALL BOLTED CONNECTIONS SHALL BE BEARING TYPE CONNECTIONS, UNLESS NOTED AS SLIP CRITICAL. WASHERS SHALL BE INSTALLED UNDER NUTS OF FASTENERS WHEN REQUIRED BY THE SPECIFICATION FOR STRUCTURAL JOINTS.

5. ALL ANCHOR RODS SHALL BE ASTM F1554, Grade 55, UNLESS OTHERWISE NOTED.

6. UNLESS OTHERWISE NOTED, ALL JOISTS, PURLINS OR SUBPURLINS SUPPORTING THE ROOF DECK SHALL BE FIELD WELDED TO SUPPORTING MEMBERS OR TO PRESET BEARING PLATES.

7. STEEL ROOF DECK SHALL BE 38 mm DEEP WR_____mm THICKNESS. STANDARD METAL DECKING SHALL BE ASTM A653 SQ GRADE 230 MPa WITH G60 METAL DECKING. DECKING SHALL BE CONTINUOUS OVER AT LEAST THREE (3) SUPPORTS EACH DECKING PANEL SHALL BE ATTACHED TO SUPPORTING MEMBERS AND ADJACENT PANELS BY 16 mm DIAMETER WELDS AS INDICATED BELOW FOR THE APPLICABLE PANEL WIDTH. IF OTHER PANEL WIDTHS ARE USED. CONTRACTOR MUST PROVIDE WELD SPACING TO PROVIDE EQUIVALENT SHEAR STRENGTH AND STIFFNESS.

	610 mm PANEL	915 mm PANEL
NO. OF END AND SUPPORT WELDS	________	________
SPACING OF SIDELAP & EDGE WELDS	_____ mm O. C.	_____ mm O. C.

WELDS SHALL BE USED FOR SEISMIC DESIGN CATEGORY C OR HIGHER. SCREWS, POWER ACTURATED FASTENERS, OR PNEUMATICALLY DRIVEN FASTENERS MAY BE USED FOR SEISMIC DESIGN CATEGORY A AND B AND FOR DESIGN WIND SPEED LESS THAN 160 Km/hr PROVIDED THE TYPE, SIZE, LENGTH, AND SPACING OF THE FASTENERS ARE SHOWN TO PROVIDE, AS A MINIMUM. THE SAME SHEAR, UPLIFT, AND STIFFNESS VALUES AS THE WELDED PATTERN INDICATED ABOVE. THE REQUIRED SUPPORTING CALCULATIONS AND DATA SHALL BE BASED UPON THE STEEL DECK INSTITUTE'S DIAPHRAGM DESIGN MANUAL. SIDELAP WELDING IS NOT RECOMMENDED FOR 0.85 mm thick DECKS.

8. SUBPURLINS SHALL BE DESIGNED TO SUPPORT LOADS SHOWN WITH DEFLECTIONS LIMITED TO L/240. WHERE L = CLEAR SPAN .

9. BETWEEN PANEL POINTS OF STEEL JOISTS, THE BOTTOM CHORD SHALL NOT SUPPORT OVER 225 N. VERTICAL LOAD WITHOUT ADEQUATE REINFORCING OF BOTTOM CHORD. NO VERTICAL LOAD SHALL BE IMPOSED ON BRIDGING.

10. CONCRETE SLABS ON METAL FORM SHALL BE 80 mm STRUCTURAL CONCRETE AND REINFORCED WITH 6X6 - W2, 9XW2. 9 - W. W. F. OR EQUIVALENT REINFORCING STEEL THE METAL FORM SHALL BE GALVANIZED AND SHALL HAVE A MINIMUM YIELD STRENGTH OF 345 MPa. USE FLOOR HARDENER ON EXPOSED FLOORS.

PRE - ENGINEERED METAL BUILDING NOTES:

1. THE BUILDING SHALL BE A MANUFACTURER'S STANDARD PREFABRICATED METAL STRUCTURE OF THE APPROXIMATE INSIDE AREA SHOWN. EXCEPT AS NOTED. RIGID FRAMES SHALL BE SPACED AT _____ CTR. TO CTR., BUT OVERALL DIMENSIONS AND CONSTRUCTION DETAILS MAY VARY TO SUIT MANUFACTURER'S STANDARD DESIGN. HOWEVER, MINIMUM WEB THICHNESS OF RIGID FRAMES SHALL BE 4.8 mm.

2. THE BUILDING SHALL BE DESIGNED AND FABRICATED ACCORDING TO THE CONTRACT SPECIFICATIONS, AISC, MBMA AND AISI LATEST SPECIFICATIONS. AMERICAN INSTITUTE OF STEEL CONSTRUCTION CERTIFICATION IS REQUIRED OF THE METAL BUILDING SYSTEM MANUFACTURER AND A CERTIFICATE TO VERIFY COMPLIANCE SHALL BE SUBMITTED WITH THE DESIGN ANALYSIS. THE DIMENSIONAL TOLERANCES OUTLINED IN THE AWS CODE UNDER WORKMANSHIP AND THE TOLERANCES APPICABLE TO HOT ROLLED STEEL UNDER THE AISC "STANDARD MILL PRACTICE" , SECTION SHALL BE REQUIRED IN THE FABRICATION OF THE STEEL BUILDING FRAMES.

** 3. THE BUILDING FRAME SHALL BE DESIGNED TO LIMIT THE LATERAL DEFLECTION TO ____ mm AT THE BUILDING EAVE FOR A BASIC WIND SPEED OF ____ Km/h.

4. A COMPLETE DESIGN ANALYSIS SHOWING ALL CALCULATIONS FOR THE RIGID FRAMES, GIRTS, PURLINGS AND X-BRACING FOR WIND AND SEISMIC LOADS AND A LAYOUT OF ANCHOR BOLTS AND OTHER EMBEDED ITEMS SHALL BE SUBMITTED FOR APPROVAL WITH THE ALL MAIN MEMBERS. TYPICAL CONNECTIONS (SHOWING BOLT HOLES AND WELDS), AND ERECTION DRAWINGS.

5. THE BUILDING SHALL BE DESIGNED TO SUPPORT ALL MECHANICAL EQUIPMENT INCLUDING HEATERS, SPRINKLERS, EXHAUST SYSTEMS AND ALL OTHER SUCH DEVICES. ADDITIONAL GIRTS OR PURLINS SHALL BE PLACED IN CONVENIENT LOCATIONS FOR ATTACHMENT OF ALL MECHANICAL EQUIPMENT.

6. DESIGN LOADS SHALL CONFORM WITH LIVE LOADS, WIND LOAD AND SEISMIC LOAD PARAMETERS GIVEN IN THE GENERAL NOTES PLUS COLLATERAL DEAD FROM MECHANICAL EQUIPMENT, CEILINGS, SPRINKLERS AND CRANE LOADS AS APPLICABLE. LOAD COMBINATIONS AND DESIGN STRESSES SHOULD COMPLY WITH AISC SPECIFICATIONS FOR STRUCTURAL STEEL BUILDINGS.

7. RIGID FRAME ANCHOR BOLTS SHALL BE DESIGNED AND FURNISHED BY THE CONTRACTOR. BOLTS SHALL BE DESIGNED BY A PROFESSIONAL ENGINEER FOR THE FRAME REACTIONS FURNISHED BY THE METAL BUILDING MANUFACTURER. THE ANCHOR BOLT DESIGN ANALYSIS SHALL BE SUBMITTED FOR APPROVAL.

8. BUILDINGS WITH SEISMIC DESIGN CATEGORY OF C OR HIGHER SHALL NOT USE METAL PANEL WALLS AND ROOF AS A DIAPHRAGM DIAPHRAGMS FOR BUILDINGS WITH SEISMIC DESIGN CATEGORY OF A OR B MUST BE A MINIMUM OF 0.85 mm THICKNESS. LOAD TEST ON METAL PANEL WALL AND ROOF ASSEMBLIES TO BE USED AS A DIAPHRAGM MUST BE SUBMITTED.

NOTE TO ENGINEER: GUIDE SPECIFICATION CEGS 13120 STANDARD METAL BUILDING SHALL BE USED FOR PREPARATION OF CONTRACT SPECIFICATIONS.

** NOTE 3: ON DRIFT MAY BE DELETED FOR UTILITARIAN BUILDINGS WITH METAL SIDING. DRIFT FOR BRICK VENEER CLADDING EQUAL H/600 FOR 10 YR WIND. DRIFT FOR REINFORCED CMU EQUAL H/400 FOR 10 YR WIND.

TABLE A - REINFORCEMENT TENSION LAPS, AND EMBEDMENT

fy = 420 MPa (60000 psi), f'c = 21 MPa (3000 psi)

BAR SIZE	BAR DIA (mm)	EMBEDMENT AND CLASS A LAP (mm)				CLASS B LAP (mm)			
		TOP BAR		OTHER BARS		TOP BAR		OTHER BARS	
		CASE 1	CASE 2	CASE 1	CASE 2	CASE 1	CASE 2	CASE 1	CASE 2
10	9.5	560	815	435	635	715	1070	560	815
13	12.7	740	1095	560	840	940	1425	740	1095
16	15.9	915	1375	715	1045	1195	1880	915	1375
19	19.1	1095	1625	840	1270	1425	2135	1095	1625
22	22.2	1600	2390	1220	1830	2060	3100	1600	2390
25	25,4	1830	2720	1400	2085	2365	3530	1830	2720
29	28.7	2060	3075	1575	2365	2670	3990	2060	3075
32	32.3	2315	3455	1780	2670	3000	4500	2315	3455
36	35.8	2565	3835	1985	2950	3330	4980	2565	3835

SEE PLATE S8A FOR NOTES FOR USE WITH TABLE A

NOTE: BAR SIZE DESIGNATION ARE IN METRIC SYSTEM SI UNITS .

NOTES FOR USE WITH TABLE A

1. TABLE A PRESENTS LENGTHS OF TENSION DEVELPMENT LENGTHS AND TENSION LAP SPLICE LENGTHS BASED ON ACI 318-95, SECTION 12.2.2.
2. CLASS A LAP LENGTHS APPLY WHEN BAR LAPS ARE STAGGERED TO LAP HALF THE BARS AT THE SAME LOCATION OR WHEN BARS ARE LAPPED AT A LOCATION WHERE THE REINFORCEMENT AREA PROVIDED IS AT LEAST TWICE THAT REQUIRED.
3. CLASS B LAP LENGTHS APPLY WHEN ALL BARS ARE SPLICED AT A LOCATION OF MAXIMUM STRESS IN THE BARS.
4. CASE 1 LENGTHS APPLY TO BEAMS AND COLUMNS WITH CONCRETE COVER EQUAL OR GREATER THAN THE BAR DIAMETER, CLEAR BAR SPACING EQUAL OR GREATER THAN THE BAR DIAMETER AND WITH STIRRUPS OR TIES NOT LESS THAN THE CODE MINIMUM THOROUTHOUT THE LENGTH IN THE TABLE; AND FOR OTHER ELEMENTS WITH CONCRETE COVER EQUAL OT GREATER THAN THE BAR DIAMETER AND CLEAR SPACING EQUAL OR GREATER THAN TWO TIMES THE BAR DIAMETER.
5. CASE 2 LENGTHS APPLY TO BEAMS AND COLUMNS WITH CONCRETE COVER LESS THAN THE BAR DIAMETER, AND CLEAR BAR SPACING LESS THAN THE BAR DIAMETER; AND FOR OTHER ELAMENTS WITH CONCRETE COVER LESS THAN THE BAR DIAMETER AND CLEAR BAR SPACING LESS THAN TWO TIMES THE BAR DIAMETER.
6. TOP BARS ARE HORIZONTAL REINFORCEMENT PLACED SO THAT MORE THAN 30 cm OF CONCRETE IS CAST BELOW THE REINFORCEMENT.
7. MULTIPLY LENGTHS SHOWN BY 0.87 FOR 28 MPa (4000 psi) CONCRETE.
8. MULTIPLY LENGTHS SHOWN BY 1.3 FOR LIGHTWEIGHT AGGREGATE CONCRETE.
9. MULTIPLY LENGTHS SHOWN BY 1.3 FOR EPOXEY-COATED BARS.

NOTES TO DESIGN ENGINEER:

(1) TABLE A DOES NOT COVER HOOKED BARS, EMBEDMENT OR SPLICE LENGTHS FOR BUNDLED BARS AND COMPRESSION BARS. PLANS SHALL DETAIL REINFORCEMENT HOOKS, LAPS AND EMBEDMENTS NOT COVERED BY THE TABLE; AND WHERE THE CLASS AND/OR CASE IS NOT CLEAR.

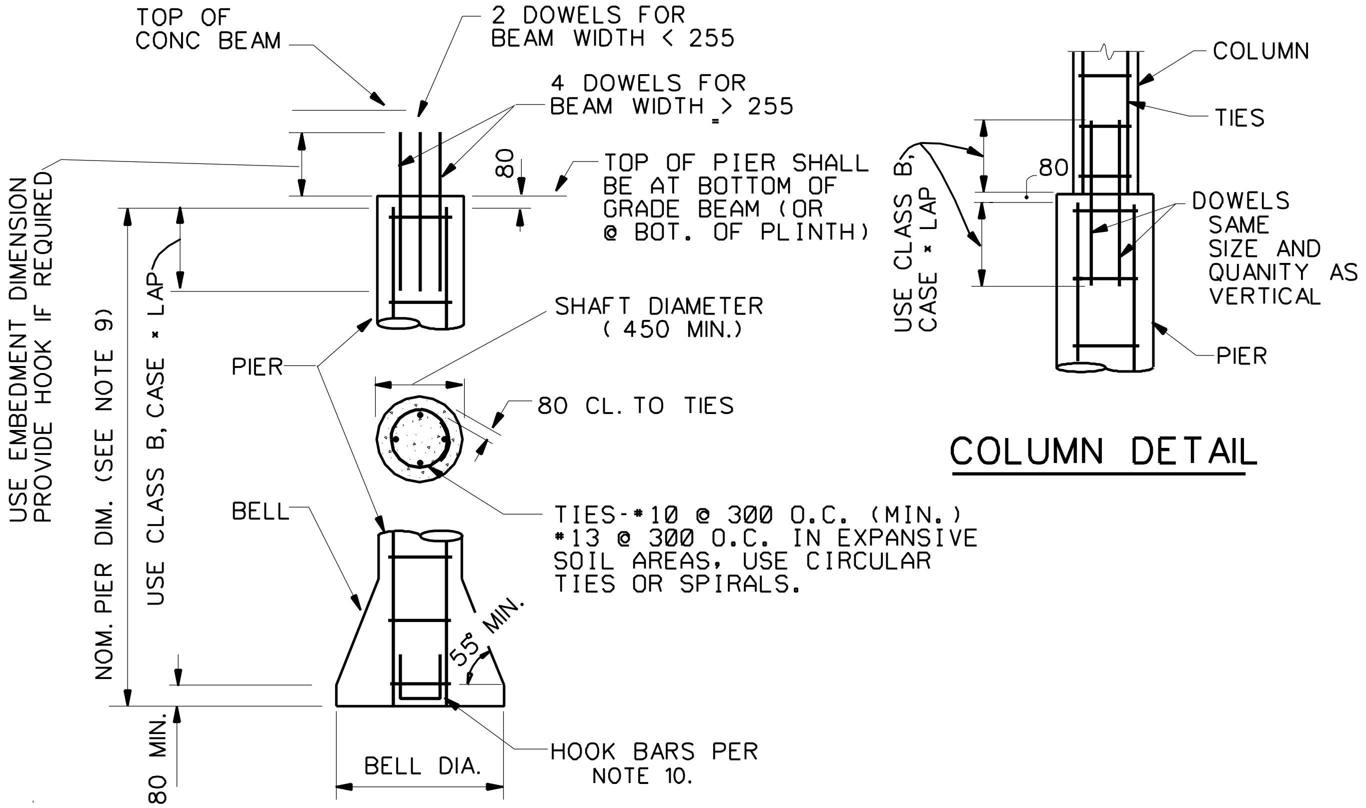
(2) THE DESIGNER SHALL VERIFY THAT PRACTICAL AND CONSTRUCTIBLE LAPS AND EMBEDMENTS WILL RESULT IN MEMBERS WHEN REINFORCEING STEEL SHOWN ON PLANS IS DETAILED WITH THE LAPS AND EMBEDMENT LENGTHS SHOWN IN TABLE A.

TABLE B
CONCRETE COVER (mm) FOR CAST-IN-PLACE NON-PRESTRESSED CONCRETE FOR BUILDINGS

DESCRIPTION		SINGLE LAYER	TWO LAYERS TOP	TWO LAYERS BOTTOM	REMARKS
SLABS	ON GRADE	40 FROM TOP	(1) 20	80	(1) 40 WHEN EXPOSED TO WEATHER
	OF RIBBED MATS	(2)			(2) T/4 (40 < T/4 < 65)
	SUPPORTED	20 FROM BOT.	20	20	T = SLAB THICKNESS
	ON CARTON FORMS	40 FROM BOT.	20	40	
	ON CONCRETE	CENTERED			
	ON METAL DECK	CENTERED			
WALLS	INTERIOR FACES	CENTERED	20		
	EXTERIOR EXPOSED FACE	CENTERED	(3) 40		(3) 50 FOR #19 AND LARGER OR EXPOSED TO EARTH

	DESCRIPTION	SIDE	TOP	BOTTOM	REMARKS
BEAMS	FORMED GRADE BEAMS	50	40	(4) 50	(4) 80 IF CAST ON EARTH
	IN RIBBED MATS	80	40	80	
	ABOVE GRADE	40	40	(5) 40	(5) 50 FOR #19 AND LARGER WHEN EXPOSED TO WEATHER
OTHER	JOISTS	20	20	20	
	SPOT FOOTINGS	(6) 40	(6) 40	80	(6) 50 FOR #19 AND LARGER WHEN
	DRILLED PIERS	80	---	---	
	COLUMNS AND PLINTHS	(7) 40	---	---	(7) 50 FOR #19 AND LARGER WHEN EXPOSED TO WEATHER

NOTE: UNLESS OTHERWISE NOTED ON DRAWINGS, CONCRETE COVER OVER PRIMARY REINFORCEMENT, TIES, STIRRUPS AND SPIRALS SHALL COMPLY WITH LISTED VALUES. COVER SHALL COMPLY WITH REQUIREMENTS OF ACI 318M FOR ELEMENTS NOT DESCRIBED.



PIER DETAIL

- NO SCALE -

COLUMN DETAIL

PER DESIGN NOTES:

1. USE 21 MPa (3000psi.) CONCRETE, SEE GENERAL NOTE 2, PLATE 4.

2. USE 100 mm TO 150 mm (4" TO 6") SLUMP CONCRETE AND 20 mm AGGREGATE TO FACILITATE CONCRETE PLACEMENT, VIBRATE ONLY TOP 1500 mm OF PIER. (IEIT SPECS ACCORDINGLY).

3. DESIGN PIER AS A SHORT TIED COLUMN.

4. VERTICAL REINFORCING IN PIERS TO BE ASTM A615M, A616M OR A617M GRADE 420.

5. MINIMUN SHAFT SIZE IS 450mm (18") FOR PIERS UP TO 12 METERS DEEP AND 600mm (24") FOR PIERS LONGER THAN 12 METERS.

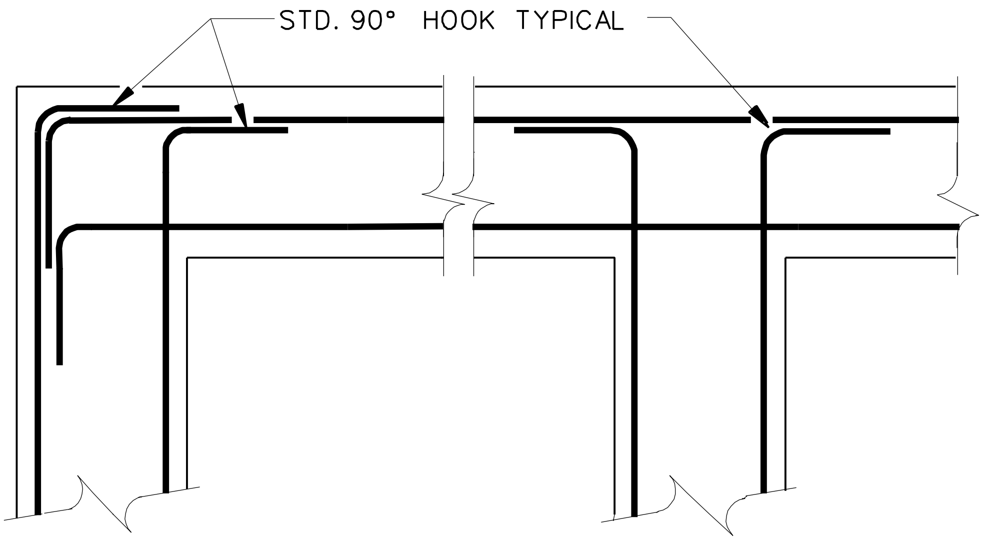
6. TO FACILITATE CONCRETE PLACEMENT, USE THE MINIMUM NUMBER OF HEAVY BARS (NOT LESS THAN FOUR [4]).

7. KEEP BELL SIZE IN INCREMENTS OF 150mm (SUCH AS 900 Dia, 1070 Dia, ETC.) TO ENABLE MACHINE BELLING. "D" NOT TO EXCEED 3 X PIER SHAFT DIAMETER ("D"); LARGER BELLS MEAN HANDLING AT HIGHER COST.

8. PIER SIZE AND REINF. MAY BE REDUCED IN SPECIAL CASES SUCH AS PORCHES FOR HOUSING, ETC. ABSOLUTE MINIMUM 300mm D/a PIER WITH 1-#16 VERTICAL BAR.

9. PIER LENGTH FOR ESTIMATING PURPOSES SHALL BE FROM BOTTOM OF PIER TO BOTTOM OF GRADE BEAM OR STUB COLUMN, ACTUAL PIER LENGTH DETERMINED IN FIELD BY CONTRACTING OFFICER.

10. WHERE REINFORCEMENT CARRIES TENSION DUE TO WIND OR SEISMIC LOADS OR SOIL HEAVE, REINFORCEMENT MUST BE DEVELOPED AT THE TOP AND BOTTOM OF THE PIER USING HOOKS OR EMBEDMENT LENGTHS INTO THE GRADE BEAM AND BELL.



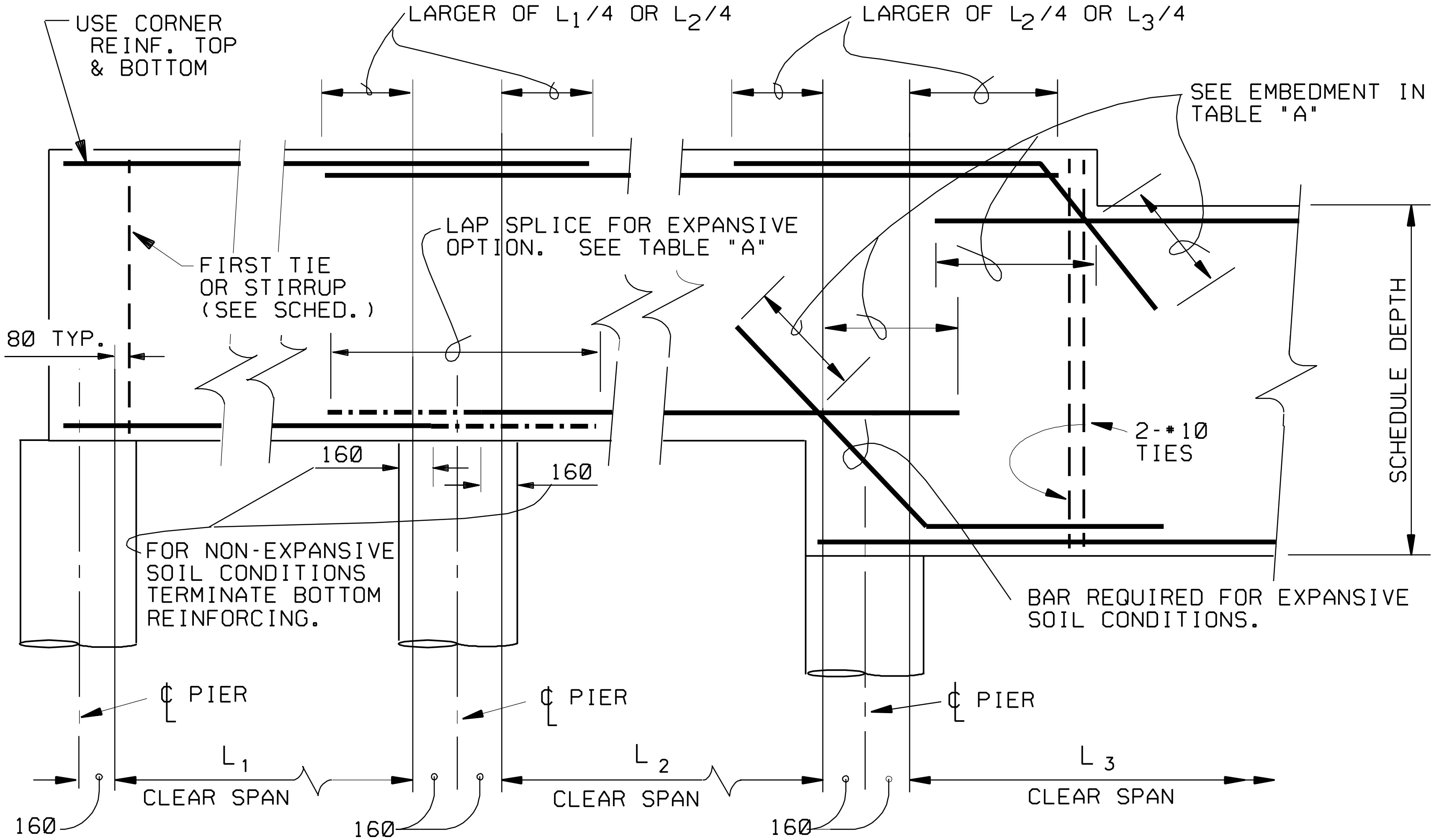
TYPICAL CORNER & INTERSECTION REINFORCING

FOR CONCRETE BEAMS AND WALLS SEE PLATE S18 FOR RIBBED MAT FOUNDATIONS.

NOTES:

(1) REINFORCING SHOWN APPLIES TO TOP, BOTTOM AND INTERMEDIATE BARS.

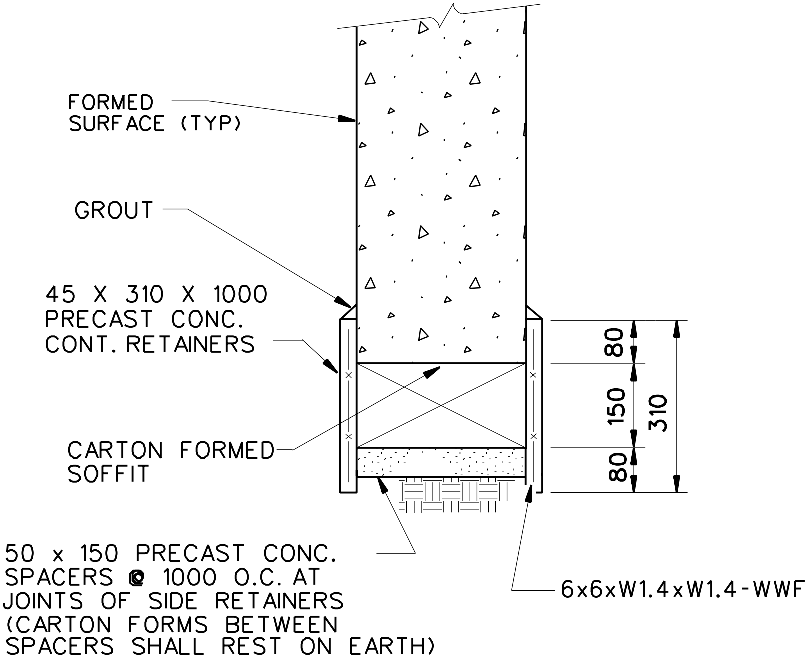
(2) THE HOOKED BARS SHOWN MAY BE REPLACED WITH HOOKED BARS THAT HAVE A CLASS A LAP WITH STRAIGHT BARS IN THE BEAM OR WALL AT THE CONTRACTORS OPTION.



TYPICAL GRADE BEAM REINFORCING DIAGRAM

NOTE: TO DESIGNER:

IN EXPANSIVE SOIL AREAS, TOP AND BOTTOM REINF. SHOULD BE CONTINUOUS DUE TO POSSIBLE FOUNDATION MOVEMENT. CONTINOUS TOP BAR SPLICES SHALL OCCUR AT MID-SPAN AND BE CLASS A.



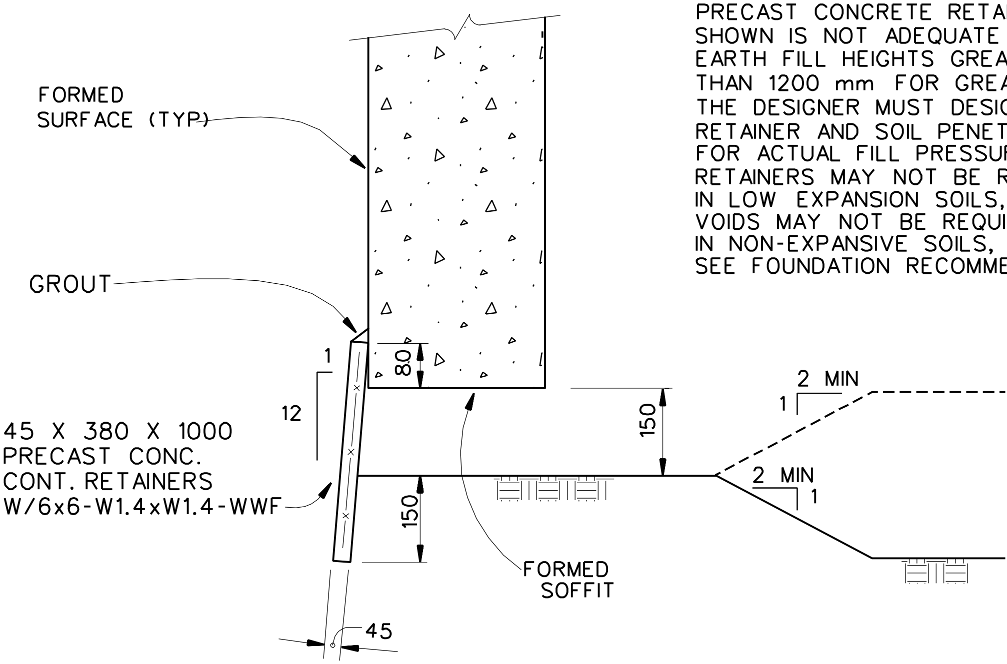
TYPICAL GRADE BEAM VOID

AT SLAB ON GRADE

\- No Scale -

DESIGN NOTE:

PRECAST CONCRETE RETAINER SHOWN IS NOT ADEQUATE FOR EARTH FILL HEIGHTS GREATER THAN 1200 mm FOR GREATER HEIGHTS THE DESIGNER MUST DESIGN THE RETAINER AND SOIL PENETRATION FOR ACTUAL FILL PRESSURES. RETAINERS MAY NOT BE REQUIRED IN LOW EXPANSION SOILS, VOIDS MAY NOT BE REQUIRED IN NON-EXPANSIVE SOILS, SEE FOUNDATION RECOMMENDATIONS

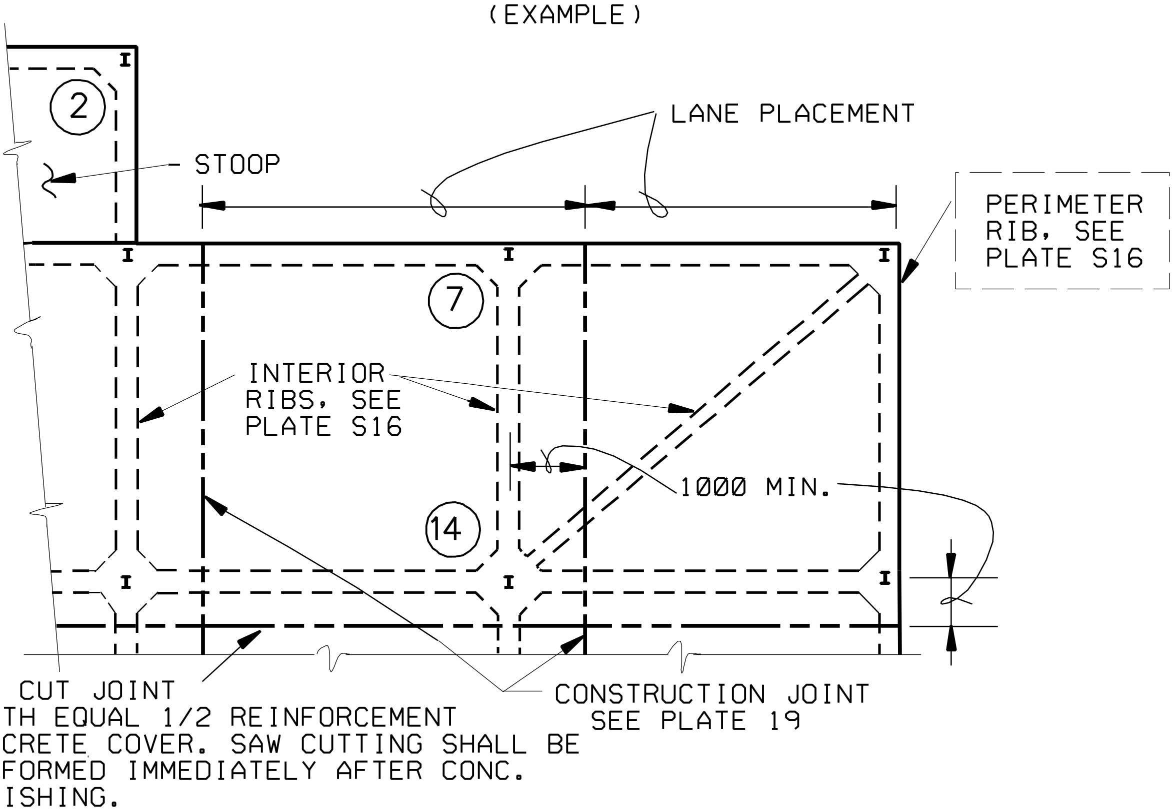


TYPICAL GRADE BEAM VOID

AT FOUNDATIONS WITH CRAWL SPACE

RIBBED MAT FOUNDATION

(EXAMPLE)



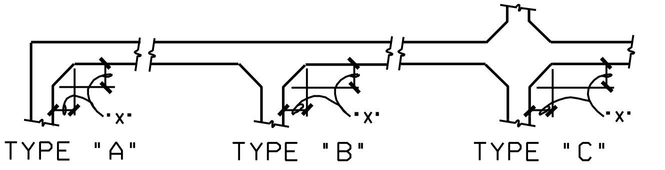
PARTIAL PLAN-FRAME CONSTRUCTION

(SHOWING ENLARGED RIB INTERSECTIONS FOR COLUMN FOOTINGS).

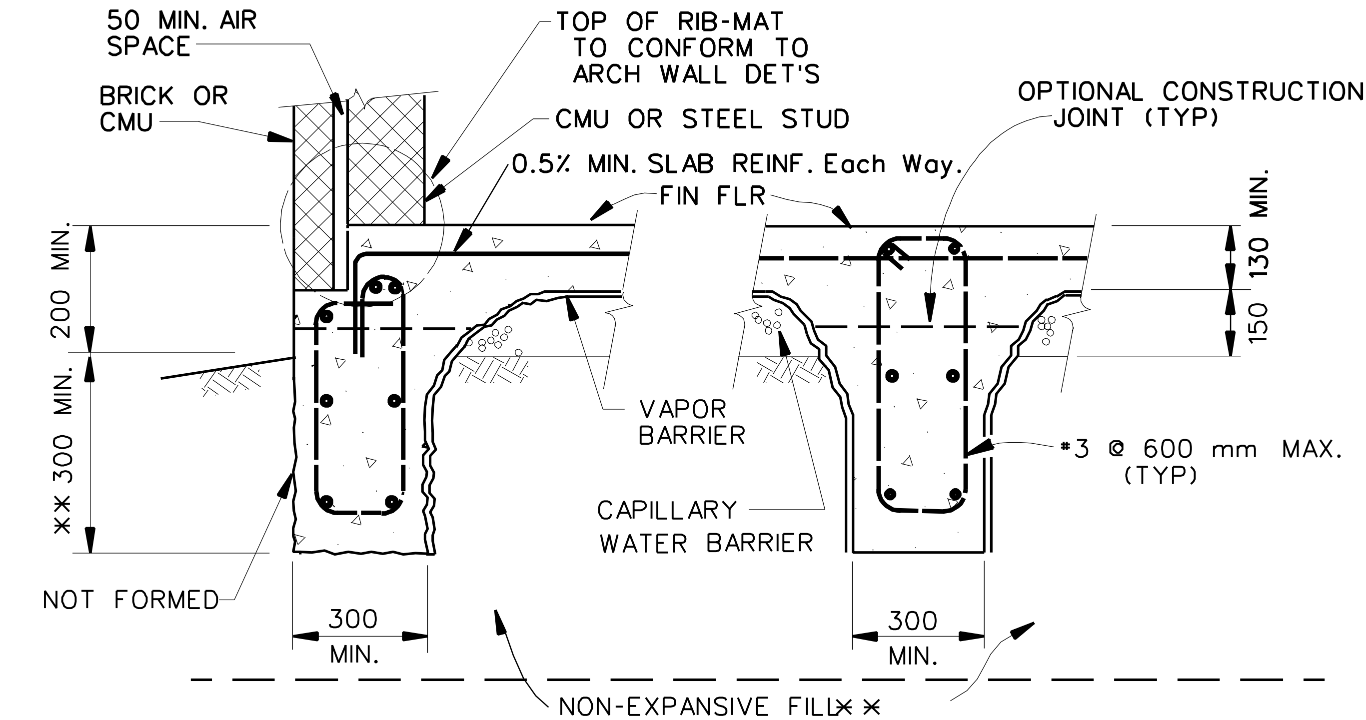
NOTE TO DESIGNER:

* DIMENSIONS SHOWN ARE MINIMUMS. USE LARGER DIMENSIONS IF REQUIRED FOR COLUMN LOADS.

FOOTING SCHEDULE



	MARK	2	7	14
	TYPE	"A"	"B"	"C"
*	DIM. "X" (MIN.)	300	300	300

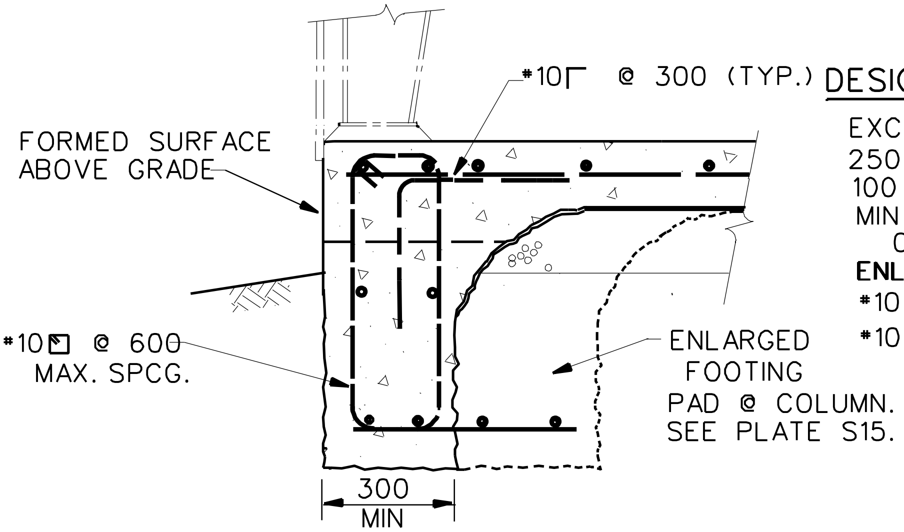


PERIMETER BEAM

(Bearing Wall)

INTERIOR RIB

✕✕ SEE FOUNDATION DESIGN ANALYSIS FOR RIB DEPTH, BELOW OUTSIDE GRADE, NON-EXPANSIVE FILL REQUIREMENTS, ETC.



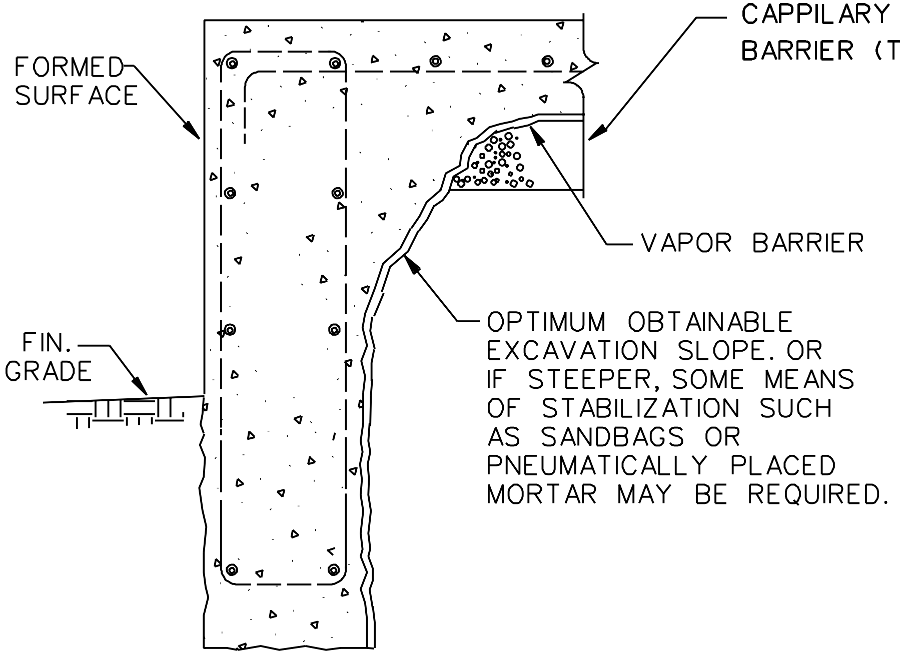
DESIGN NOTES:

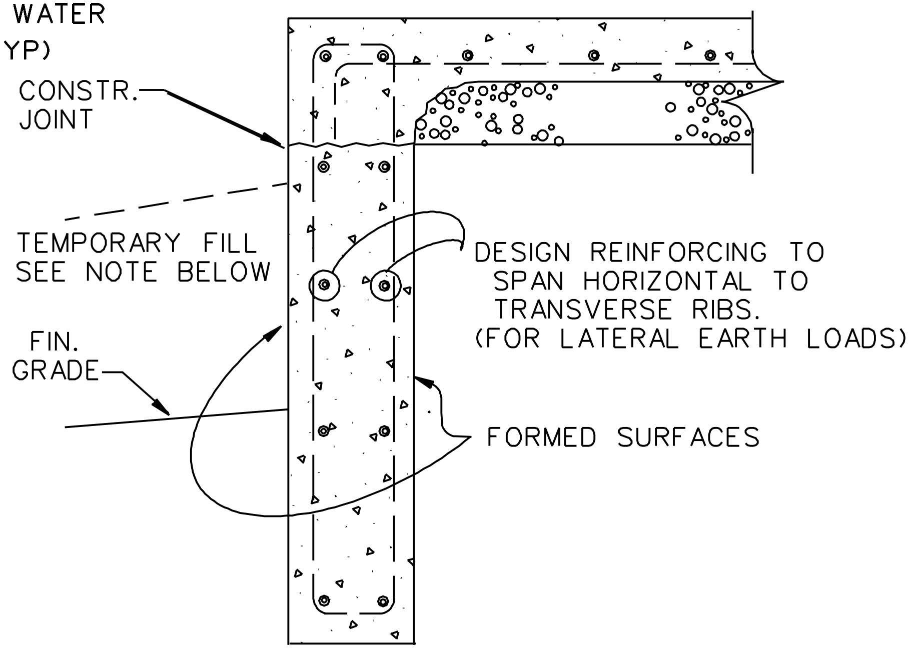
EXCEPTIONS FOR FAMILY HOUSING:
250 mm MIN. RIB WIDTH
100 mm MIN. SLAB THICKNESS
MIN RIB REINF. 0.25% TOP & 0.25% BOTTOM.
ENLARGED FOOTING NOT REQUIRED
#10 @ 600 mm NOT REQUIRED.
#10 @ 600 mm, SLAB TO PERIMETER RIBS.

PERIMETER BEAM

(RIGID FRAME)

RIBBED MAT FOUNDATION SECTIONS

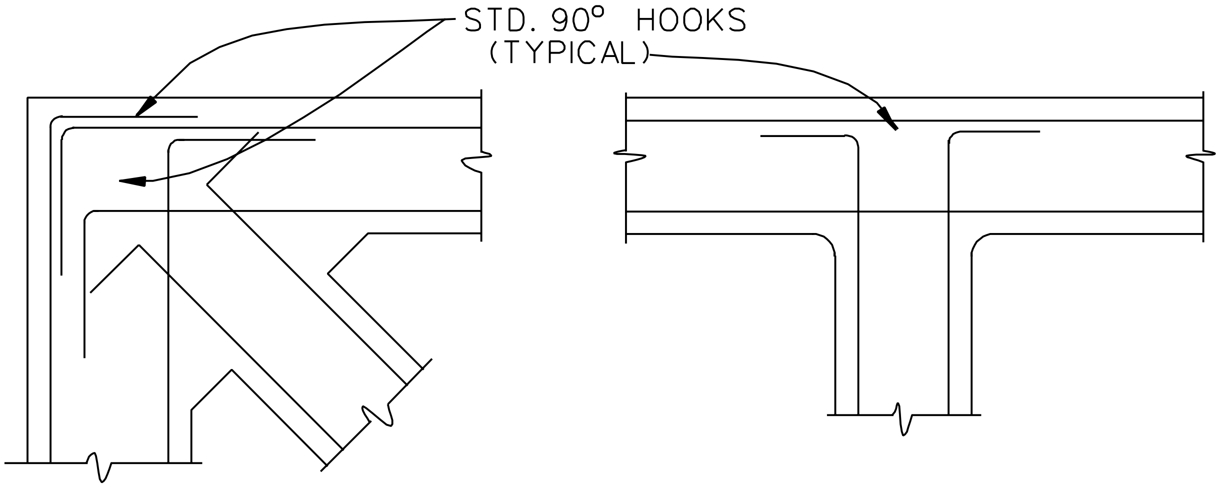




NOTE:

BACKFILL EACH SIDE
OF RIB SIMULTANEOUSLY.
LEAVE TEMPORARY
BACKFILL IN PLACE
UNTIL SLAB IS PLACED.

OPTIONAL CONSTRUCTION DETAILS OF EXTERIOR RIBS FOR RIBBED MAT CONSTRUCTION

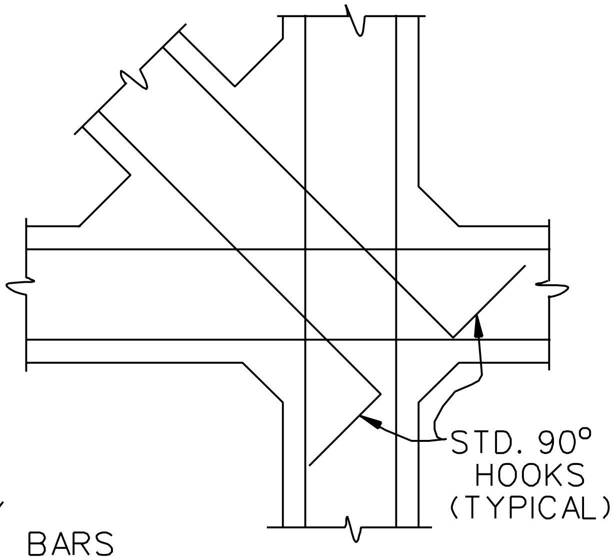


CORNER

INTERSECTION

NOTES:

1. REINFORCING SHOWN APPLIES TO TOP, BOTTOM AND INTERMEDIATE BARS.
2. SEE TABLE "A" FOR SPLICE REQUIREMENTS.
3. THE STANDARD 90° HOOKS ON DIAGONAL AND TRANSVERSE RIB REINFORCEMENT MAY BE VERTICAL RATHER THAN HORIZONTAL.
4. THE HOOKED BARS SHOWN MAY BE CHANGED TO HOOKED BENT BARS THAT LAP WITH STRAIGHT BARS IN THE CONTRACTOR's AT THE CONTRACTOR's OPTION.

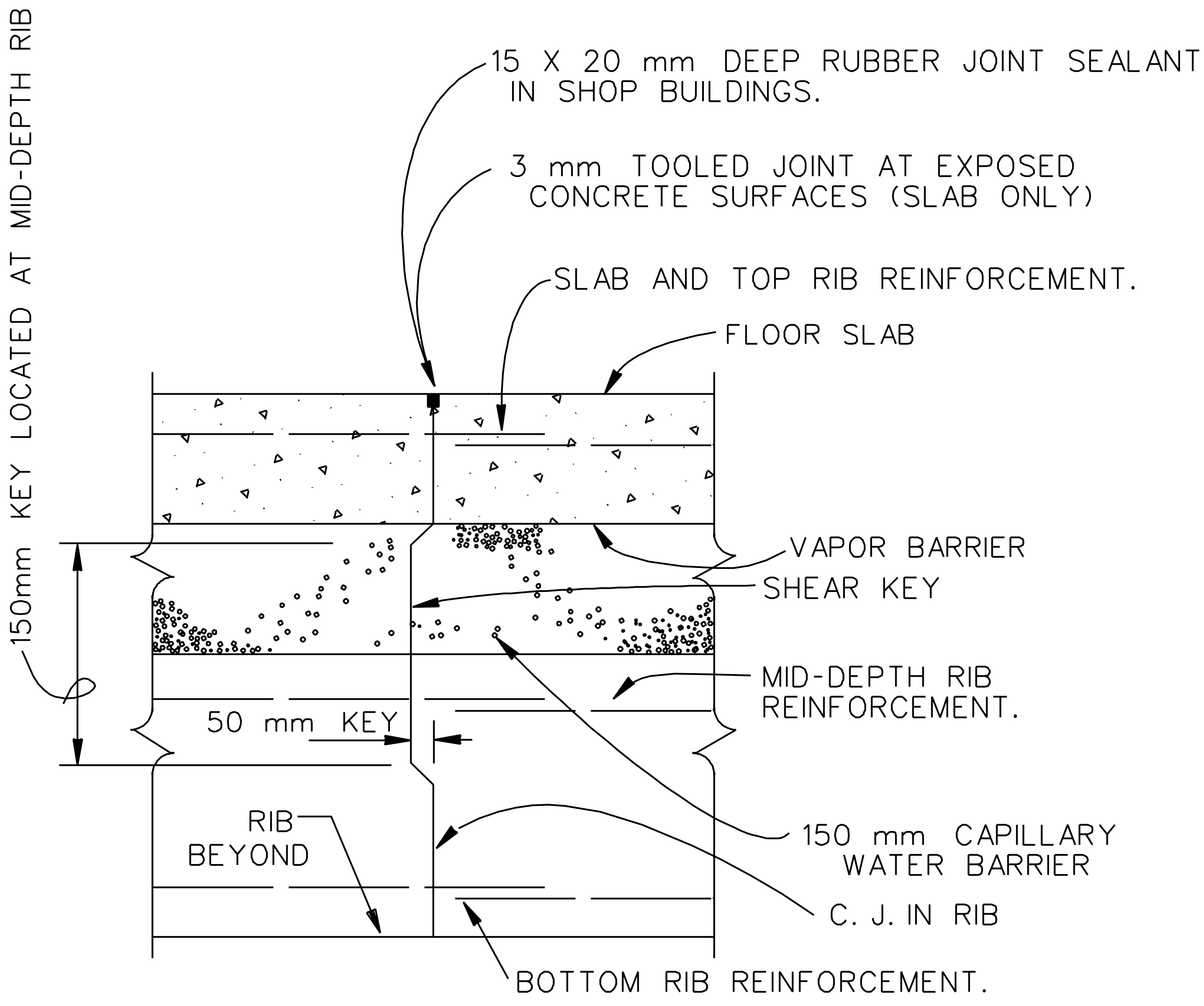


INTERIOR INTERSECTION

RIBBED MAT FOUNDATIONS

- TYPICAL RIB REINFORCEMENT -

NO SCALE



RIBBED MAT CONSTRUCTION JOINT (C.J.)

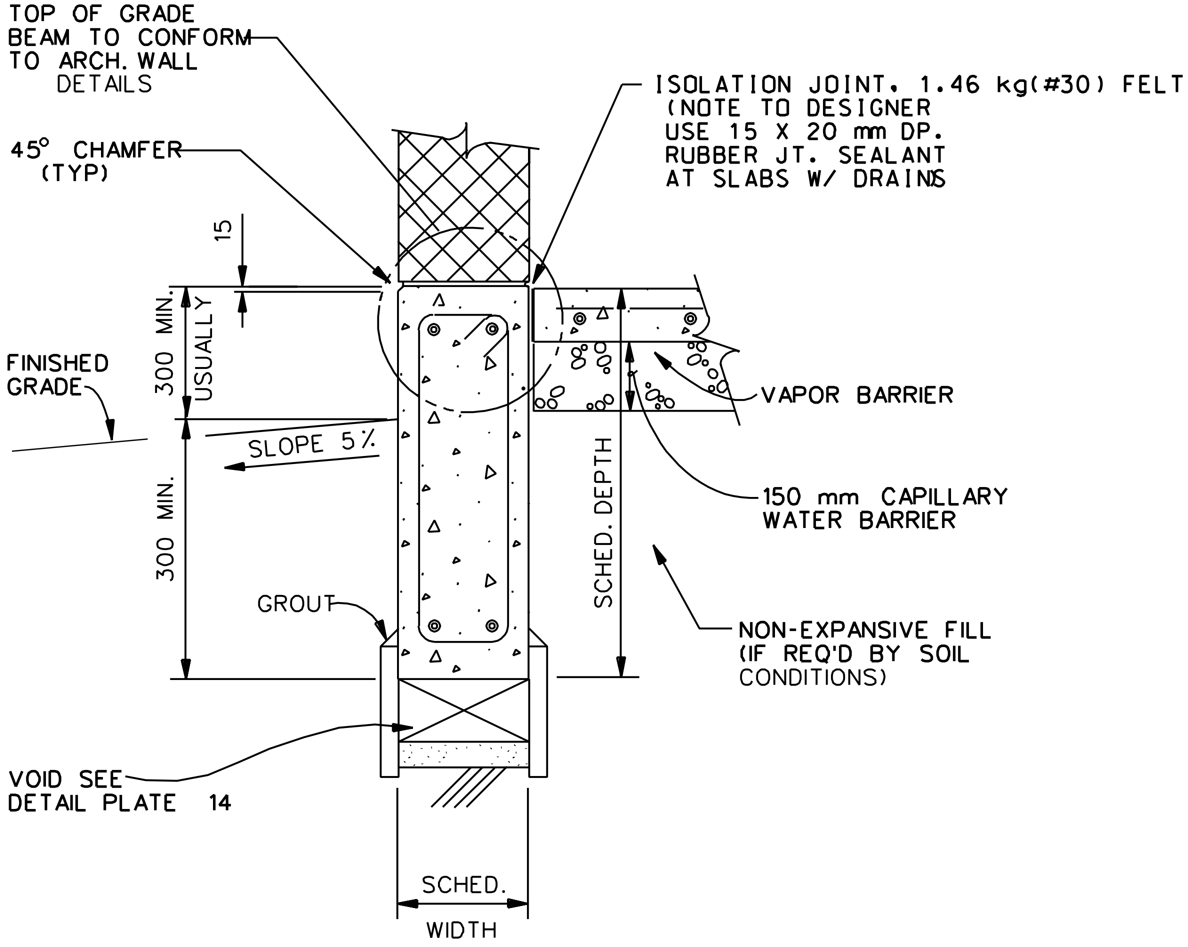
FLOOR SLAB AND RIB REINFORCEMENT LAPS SHALL BE CLASS B.

DESIGN NOTES:

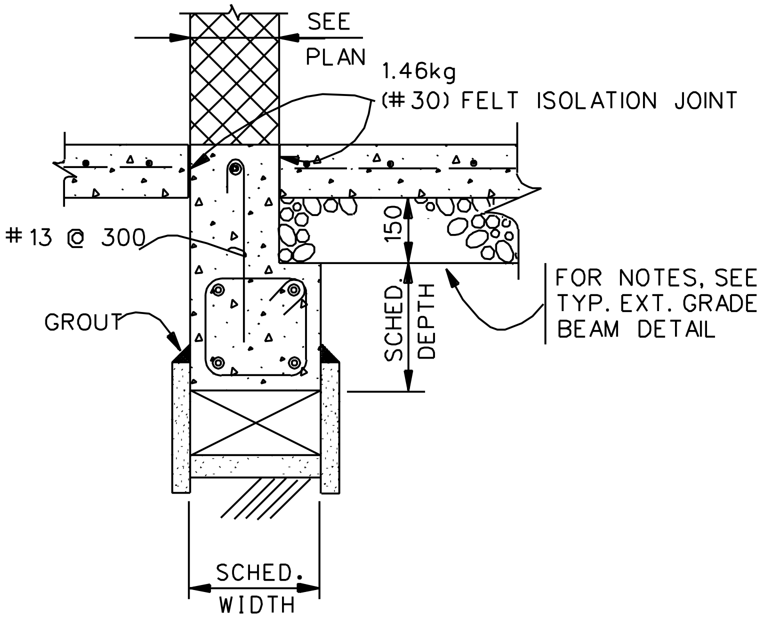
1. CONSTRUCTION JOINTS ARE TO BE SHOWN ON THE FOUNDATION PLAN IN RIBBED MATS THRU RIBS AND SLAB. SHOW JOINTS ON THE FOUNDATION PLAN.

2. ALL REINFORCING IS CONTINUOUS ACROSS THE CONSTRUCTION JOINT.

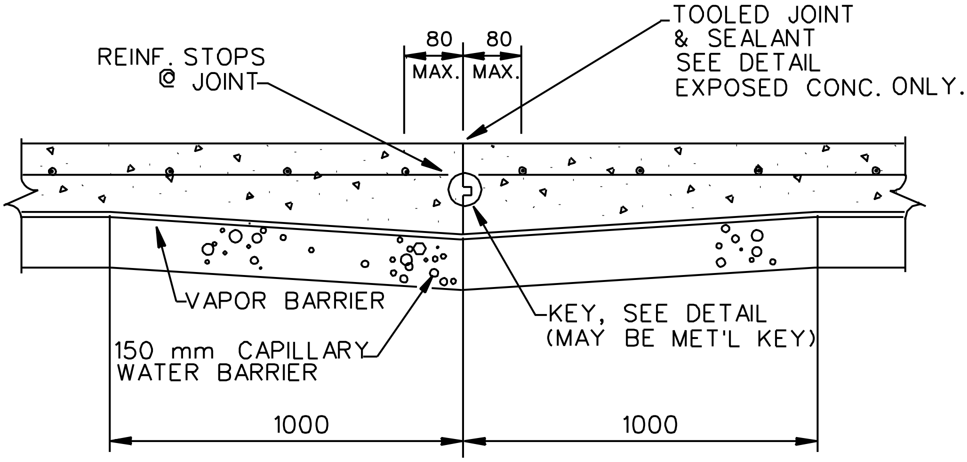
3. THE REQUIREMENT FOR THE TOOLED JOINT AND JOINT SEALANT IS TO BE DETERMINED BY THE DESIGNER.



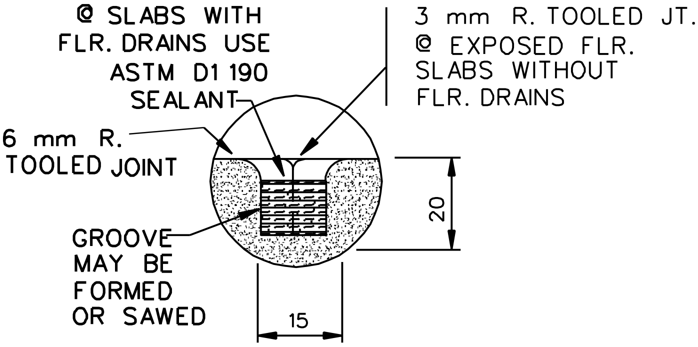
TYPICAL EXTERIOR GRADE BEAM



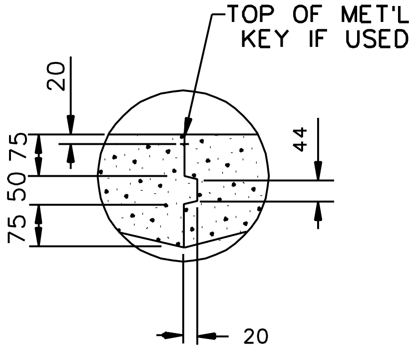
TYPICAL INTERIOR GRADE BEAM



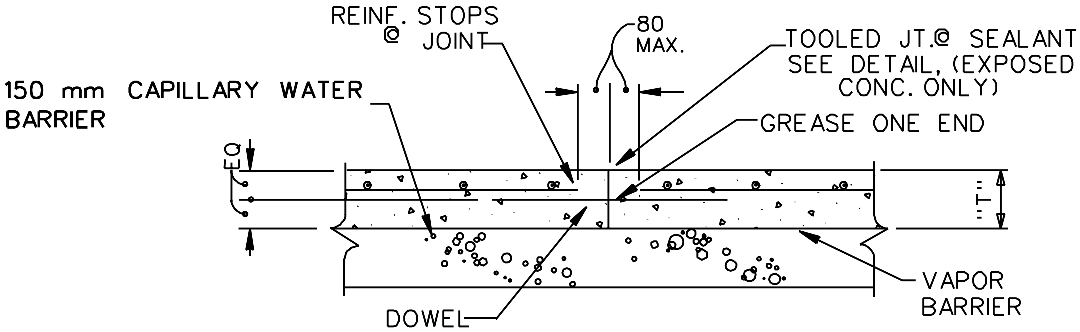
KEYED OPTION



TOOLED JT. & SEALANT



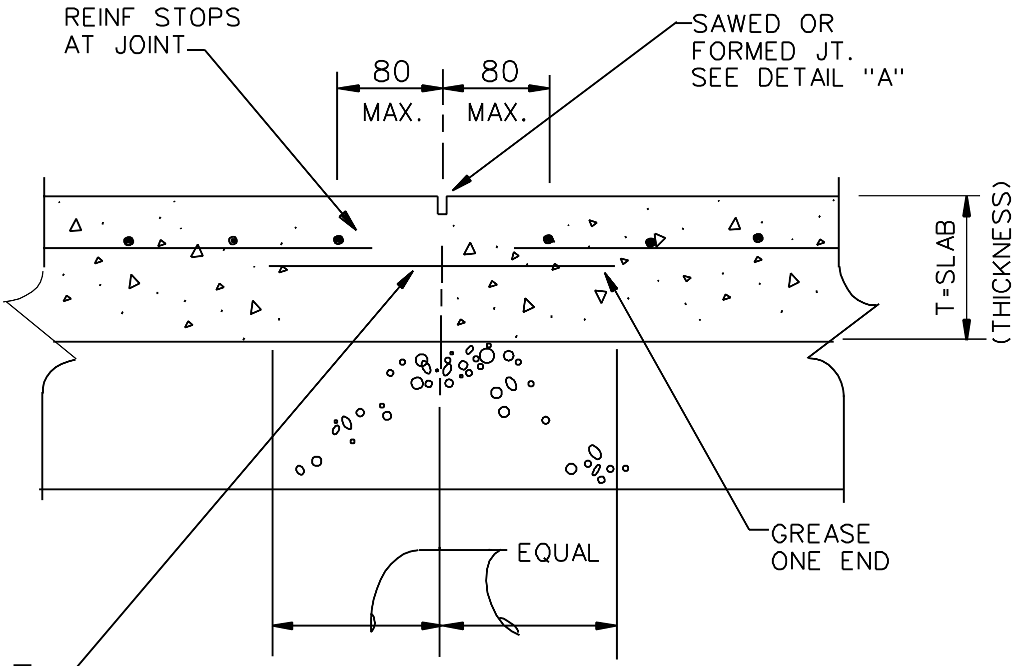
DETAIL OF KEY



FOR SLABS WITH WHEEL LOADING	FOR OTHER SLABS
20 Ø x 400 LONG@ 300 O.C. FOR T < 200 25 Ø x 450 LONG @ 300 O.C. FOR 200 ≤ T < 280	20 Ø x 400 LONG @ 400 O.C. FOR T = 100 & 125 @ 300 O.C. FOR 125 < T < 200

DOWELED OPTION
(CONTRACTION TYPE)

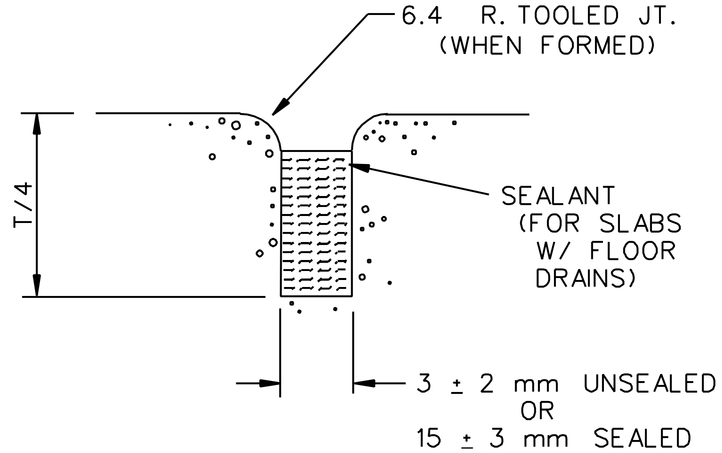
CONSTRUCTION JOINT DETAILS
(FOR FLOOR SLABS ON GRADE EXCEPT RIB-MATS)



DOWEL

(ONLY FOR SLABS SUBJECTED TO
SIGNIFICANT WHEEL LOADINGS)

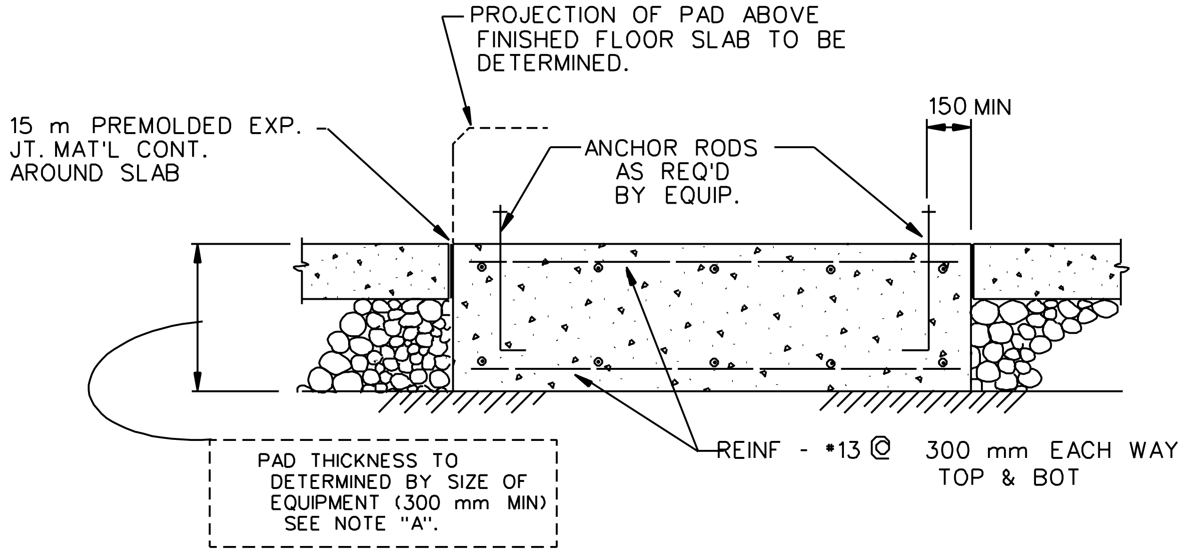
20 Ø x 400 LONG @ 300 O.C. (MAX.) FOR T<200 mm
25 Ø x 450 LONG @ 300 O.C. (MAX.) FOR 200≤ T < 290 mm



DETAIL "A"

(SAWED OR FORMED)

WEAKENED PLANE JOINT DETAILS

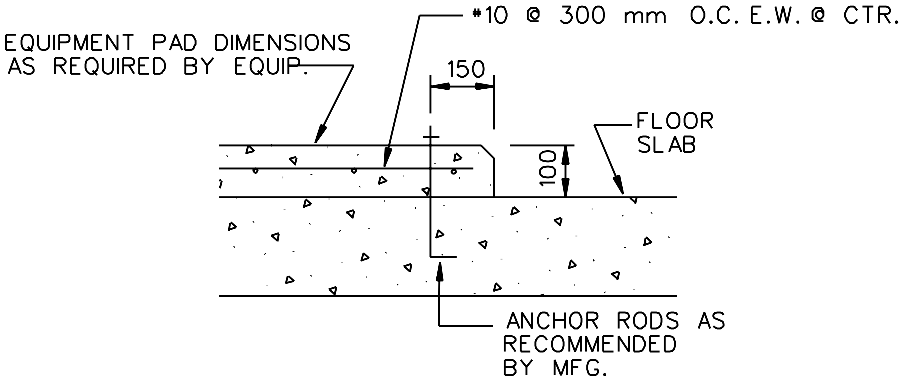


ENGINE GENERATOR SET PAD DETAIL

NO SCALE

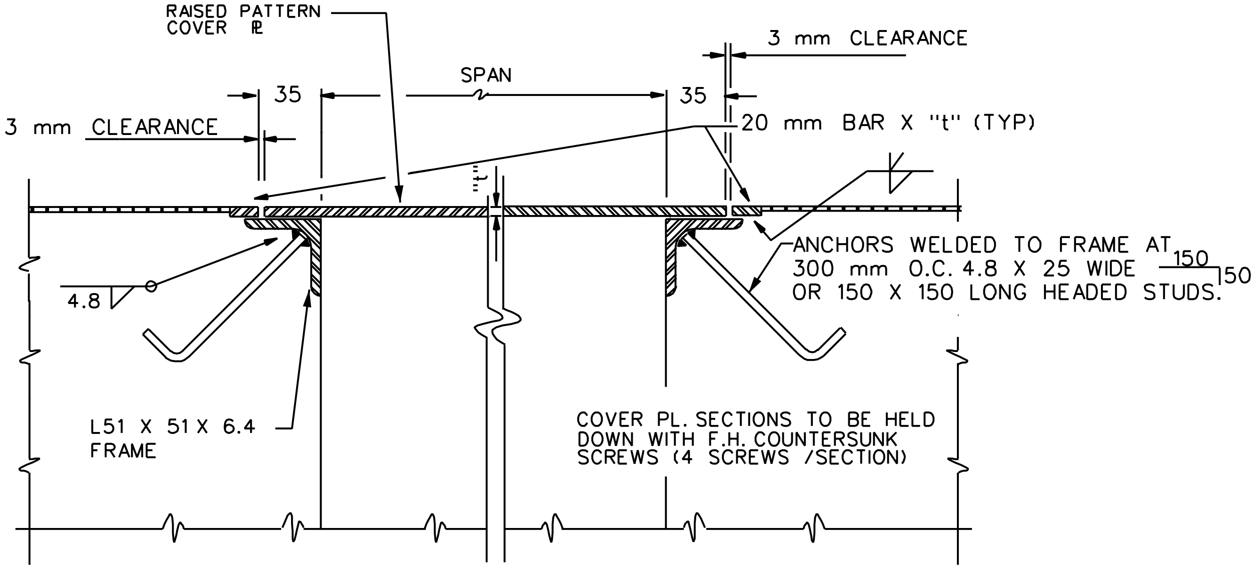
NOTE "A"

WEIGHT OF CONC. PAD TO BE 5 TIMES THE MASS OF ROTATING PARTS & A MINIMUM OF 1.5 TIMES THE TOTAL MASS OF SET. FOR HIGH PRESSURE AIR COMPRESSORS OR OTHER EQUIPMENT WHICH WILL PRODUCE A SIGINIFICANT VIBRATION.



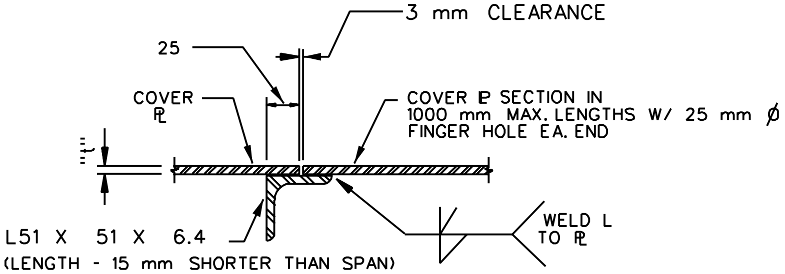
SECTION THRU EQUIPMENT PADS

NO SCALE



TRENCH COVER PLATE DETAILS

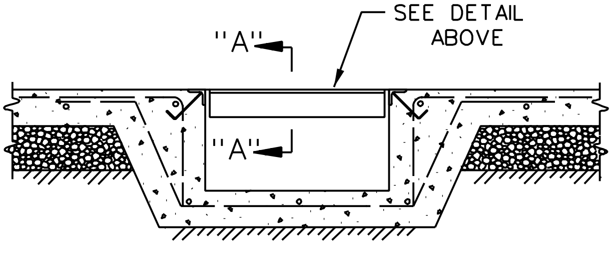
-NTS-



SECTION "A-A"

SPAN mm	"t" mm
300	3.2
450	4.8
600	6.4
750	7.9
900	9.5
1050	11.1

MINIMUM COVER PLATE THICKNESS

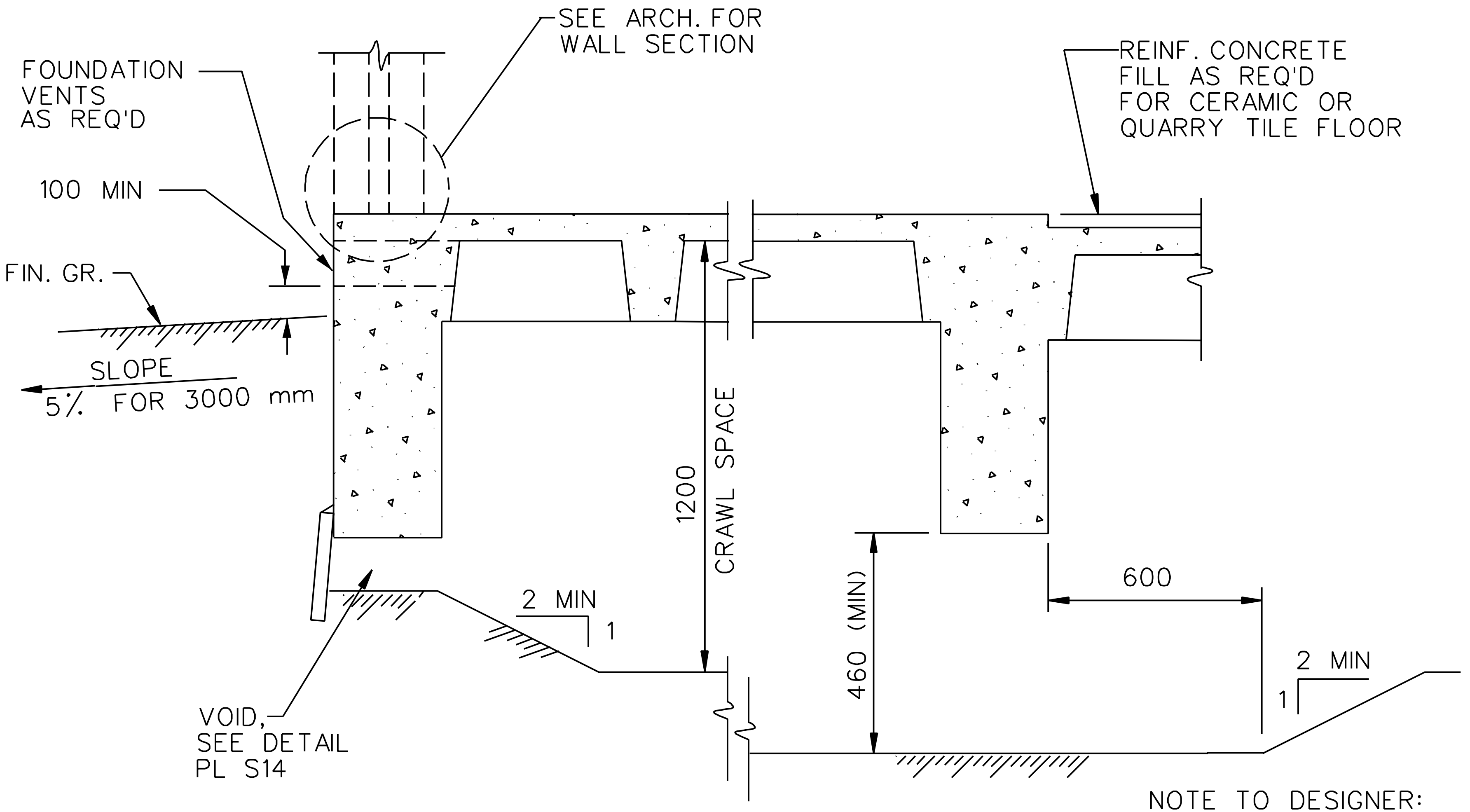


TYPICAL TRENCH SECTION

- NO SCALE -

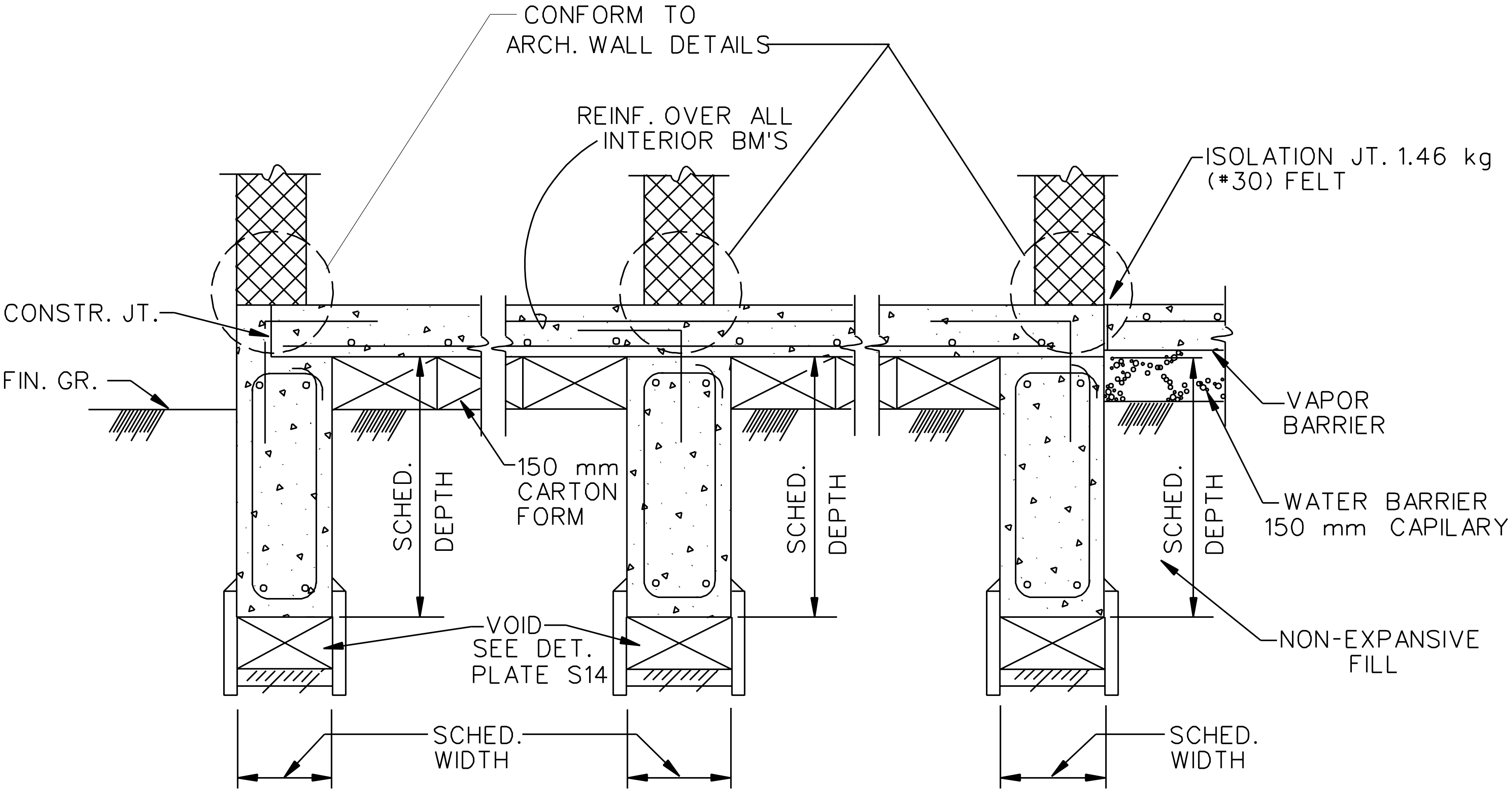
(APPLIES ALSO TO SIDE WALK DRAINS, FUEL TRENCHES, ETC.)

TYPICAL FLOOR TRENCH DETAILS



NOTE TO DESIGNER:
PROVIDE JOISTS UNDER INTERIOR PARTITIONS PARALLEL TO JOISTS

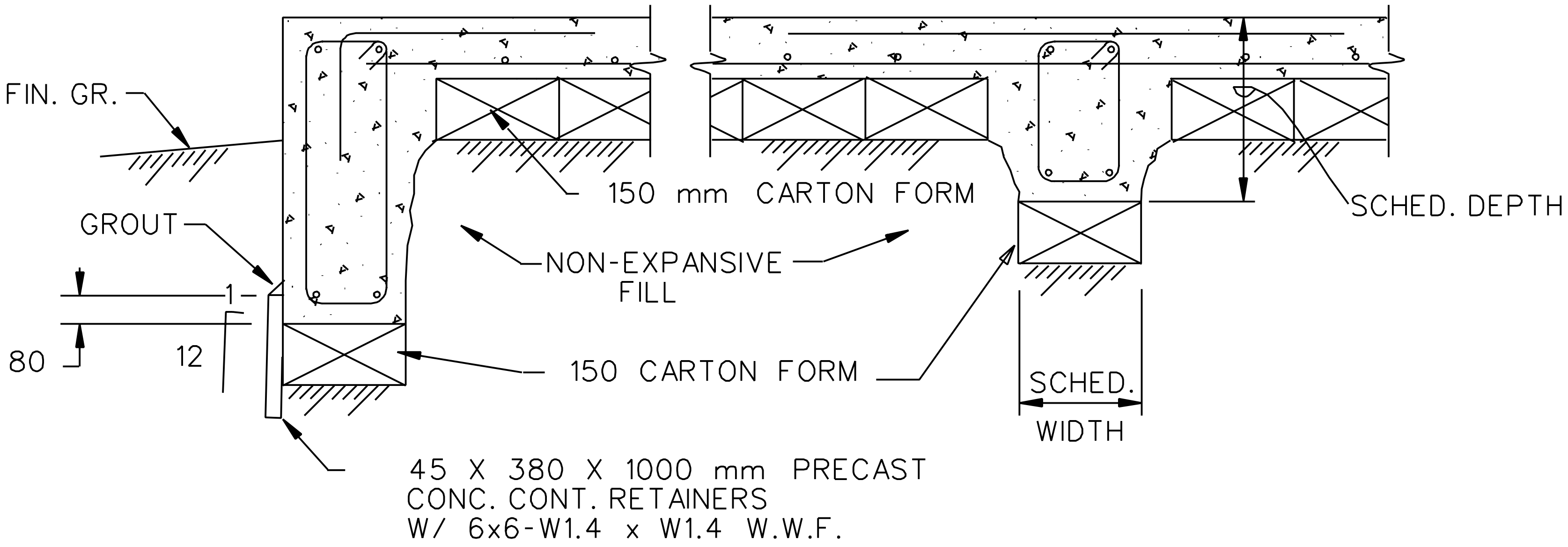
SUPPORTED FIRST FLOOR SLAB OVER CRAWL SPACE



TYPICAL STRUCTURALLY SUPPORTED FIRST FLOOR SLAB

ON CARTON FORMS - EXPANSIVE SOILS

PLATE S26



SUPPORTED FLOOR W/ CARTON FORMS

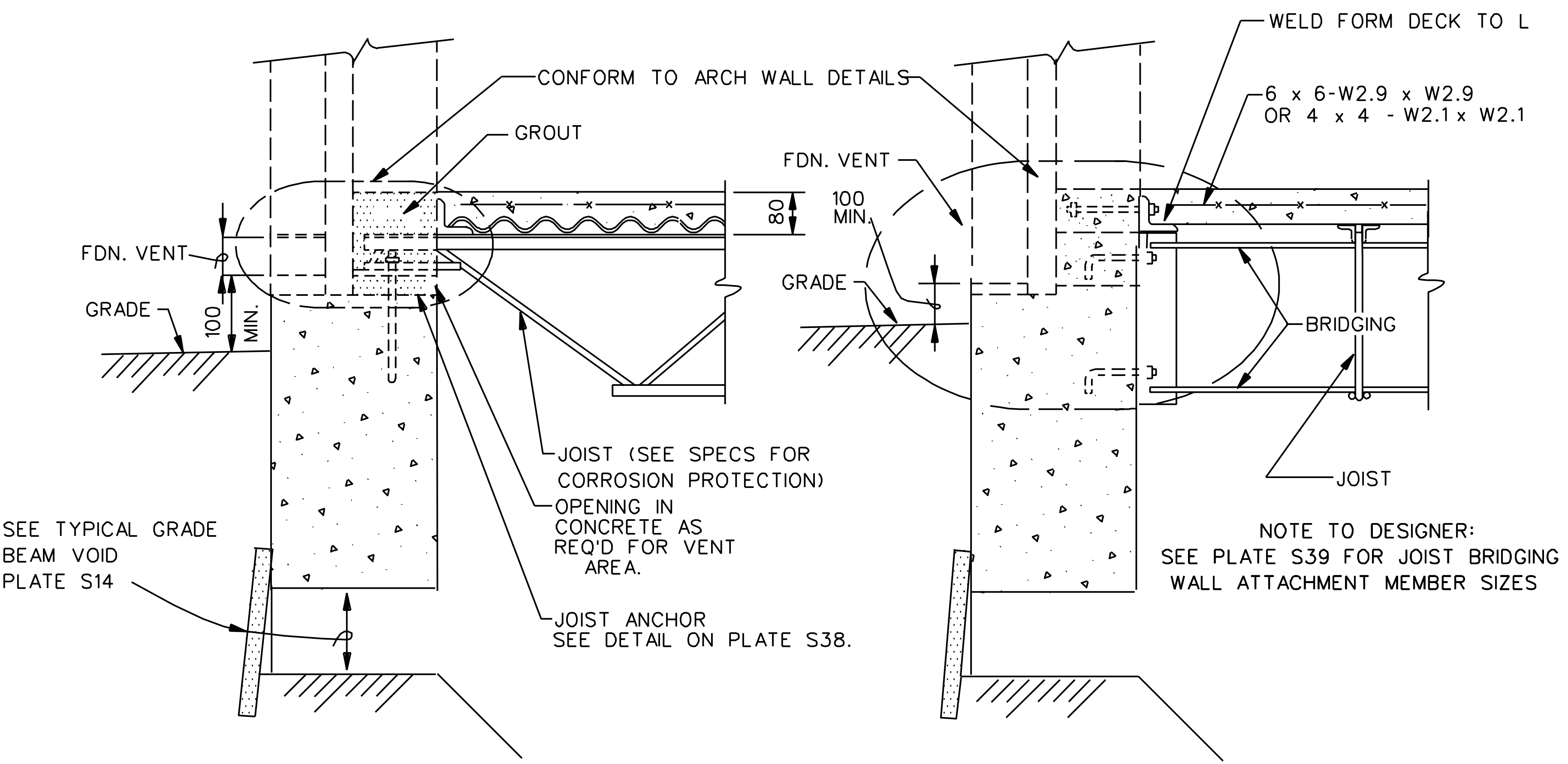
(SLAB MONOLITHIC W/ GRADE BEAMS)

NOTE TO DESIGNER:

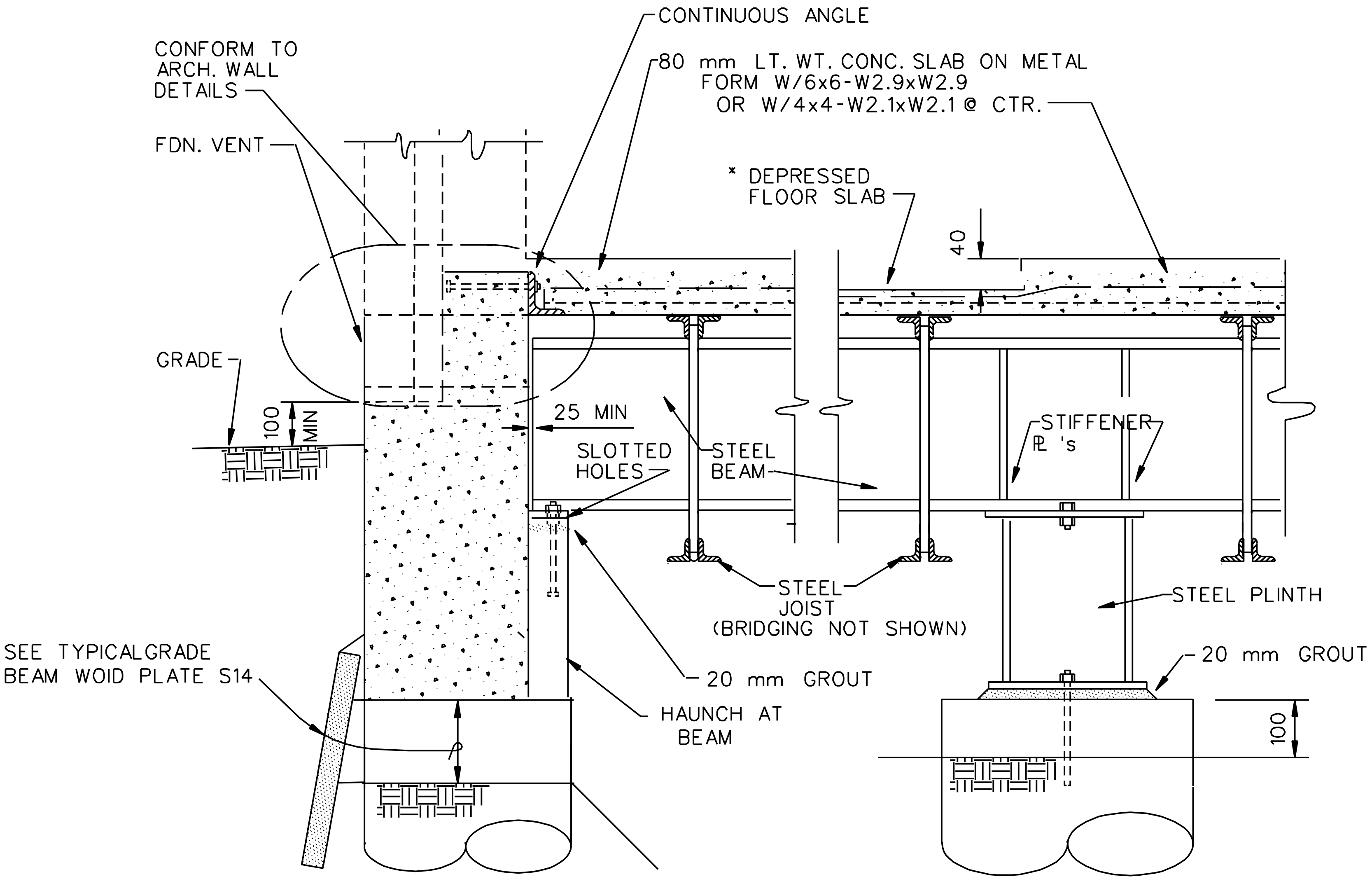
THIS TYPE OF CONSTRUCTION MAY BE SUITABLE FOR AREAS OF "MODERATE" EXPANSIVE SOIL TO REDUCE COSTS OF FORMING AND PRECAST RETAINERS IN LIEU OF VOID DETAIL ON PLATE S26.

USE THIS VOID DETAIL ONLY AFTER CONSULTATION AND CONCURRENCE FROM GEOTECHNICAL ENGINEER.

(NON-EXPANSIVE TO MODERATELY EXPANSIVE SOILS)



STRUCTURALLY SUPPORTED FLOOR (BAR JOISTS ON GRADE BEAMS)

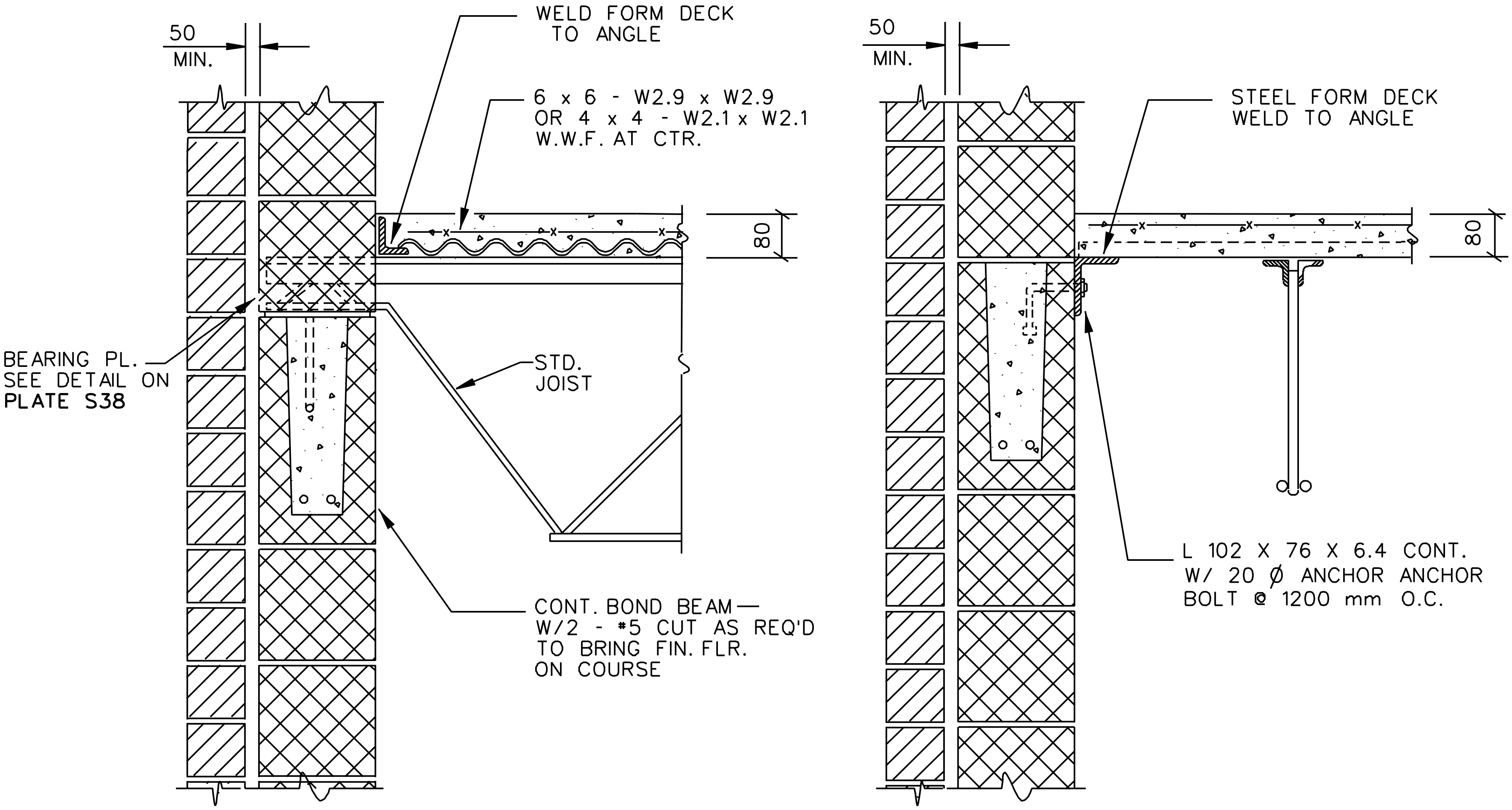


STRUCTURALLY SUPPORTED FLOOR (BAR JOISTS ON STEEL BEAMS)

NOTE TO DESIGNER :

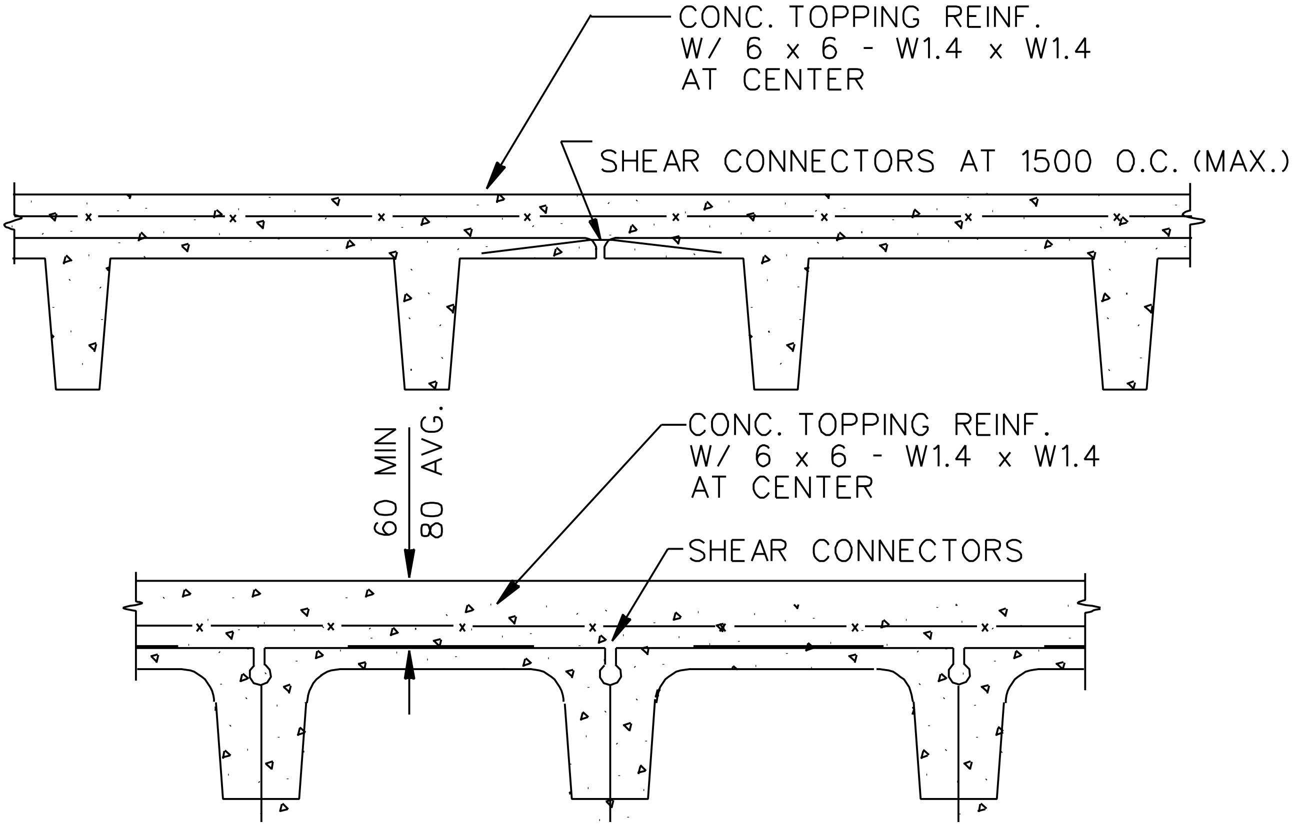
WHEN SMALL AREAS WITH LIGHT FLOOR LOAD WILL REQUIRE A DEPRESSED FLOOR SLAB, SUCH AS TOILETS, FRAMING WILL NOT BE DROPPED, 40 mm SLAB & 40 mm TILE & SETTING BED IS CONSIDERED ADEQUATE.

SPECIFICATIONS SHALL BE EDITED TO ADDRESS CORROSION PROTECTION REQUIREMENTS FOR STEEL BEAMS AND JOISTS IN CRAWL SPACES.



TYPICAL LOADBEARING WALL 2ND FLR. DETAILS

DESIGN NOTE: TYPICAL DETAILS FOR REGIONS OF LOW SEISMICITY (SEISMIC DESIGN CATAGORIES A & B) IN HIGHER SEISMIC ZONES, THESE DETAILS MUST BE REVISED AS NECESSARY TO TRANSFER FLOOR DIAPHRAGM SHEAR INTO THE WALL.



TYPICAL PRECAST FLOOR SYSTEMS

NOTES:

1. PRECAST FLOOR SYSTEM MAY BE DOUBLE TEE, CHANNEL SLAB OR CORED SLAB, PRESTRESSED OR NOT, LIGHTWEIGHT OR HARDROCK CONCRETE DESIGNED AS CONTINUOUS OR SINGLE SPANS WITH (EXCEPT AT DEPRESSED AREAS) OR WITHOUT COMPOSITE ACTION WITH TOPPING.

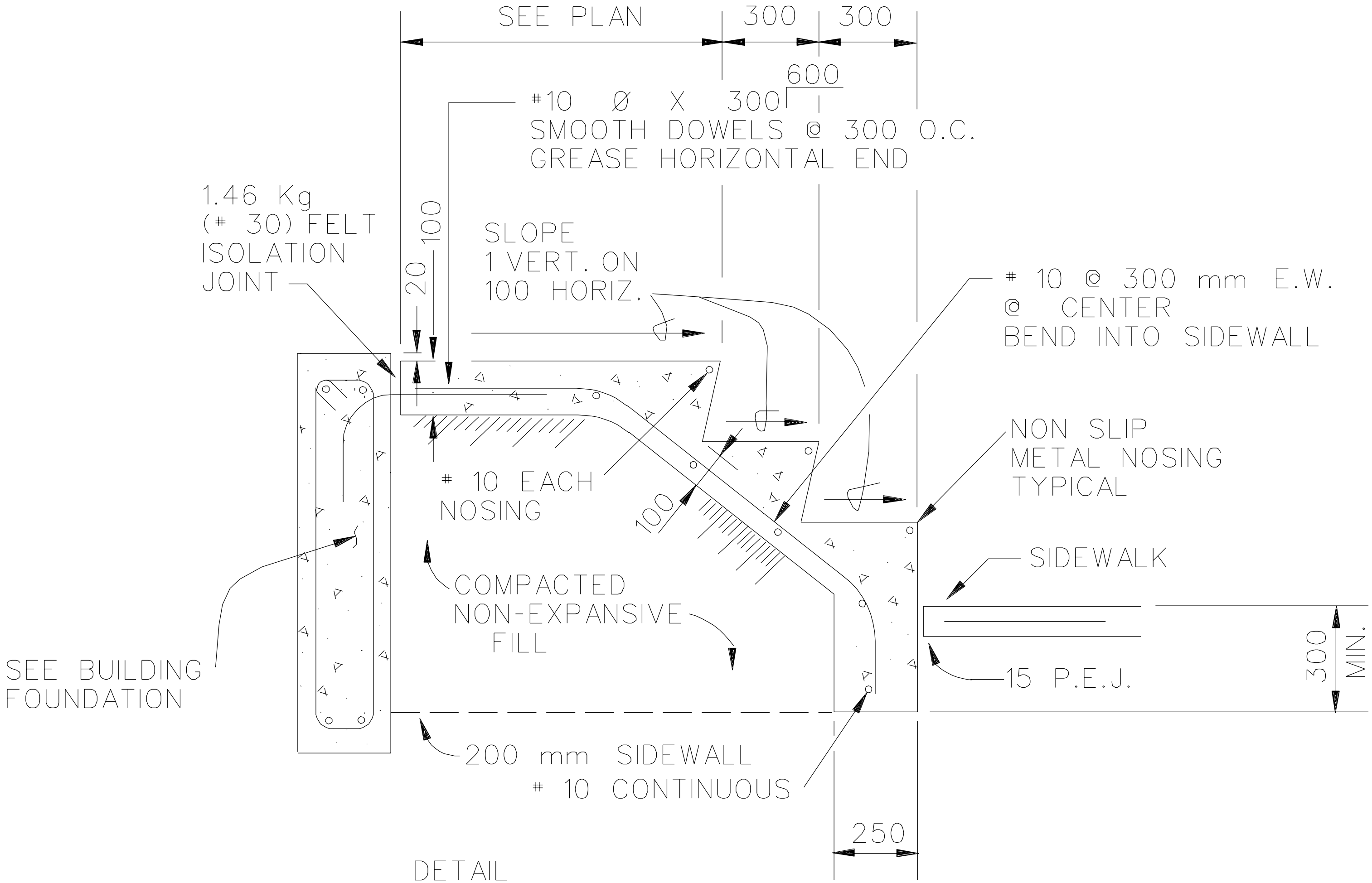
2. FLOOR SYSTEMS SHALL BE DESIGNED FOR THE LIVE LOADS SHOWN AND FOR THE ACTUAL DEAD LOADS. DESIGN FOR EQUIPMENT LOADS IF GREATER THAN LIVE LOADS.

3. PRECAST BEAMS SHOULD BEAR ON 3 mm NEOPRENE PADS (70 DUROMETER).

4. PRECAST UNITS WILL BE 28 MPa CONCRETE (MIN) AND HAVE NOT MORE THAN 15 mm INPLACE DIFFERENTIAL CAMBER BETWEEN ADJACENT UNITS.

5. TOPPING SHALL BE 21 MPa HARDROCK OR LT. WT. CONC WITH A MINIMUM THICKNESS OF 60 mm AT ANY POINT (EXCEPT AT DEPRESSED AREAS) AND VARY IN THICKNESS AS REQUIRED BY CAMBER IN UNITS SO AS TO PROVIDE A LEVEL FINISHED FLOOR UNDER DEAD LOADS. EMBEDMENT OF CONDUIT OR OTHER PIPING IN TOPPING SHALL NOT BE ALLOWED.

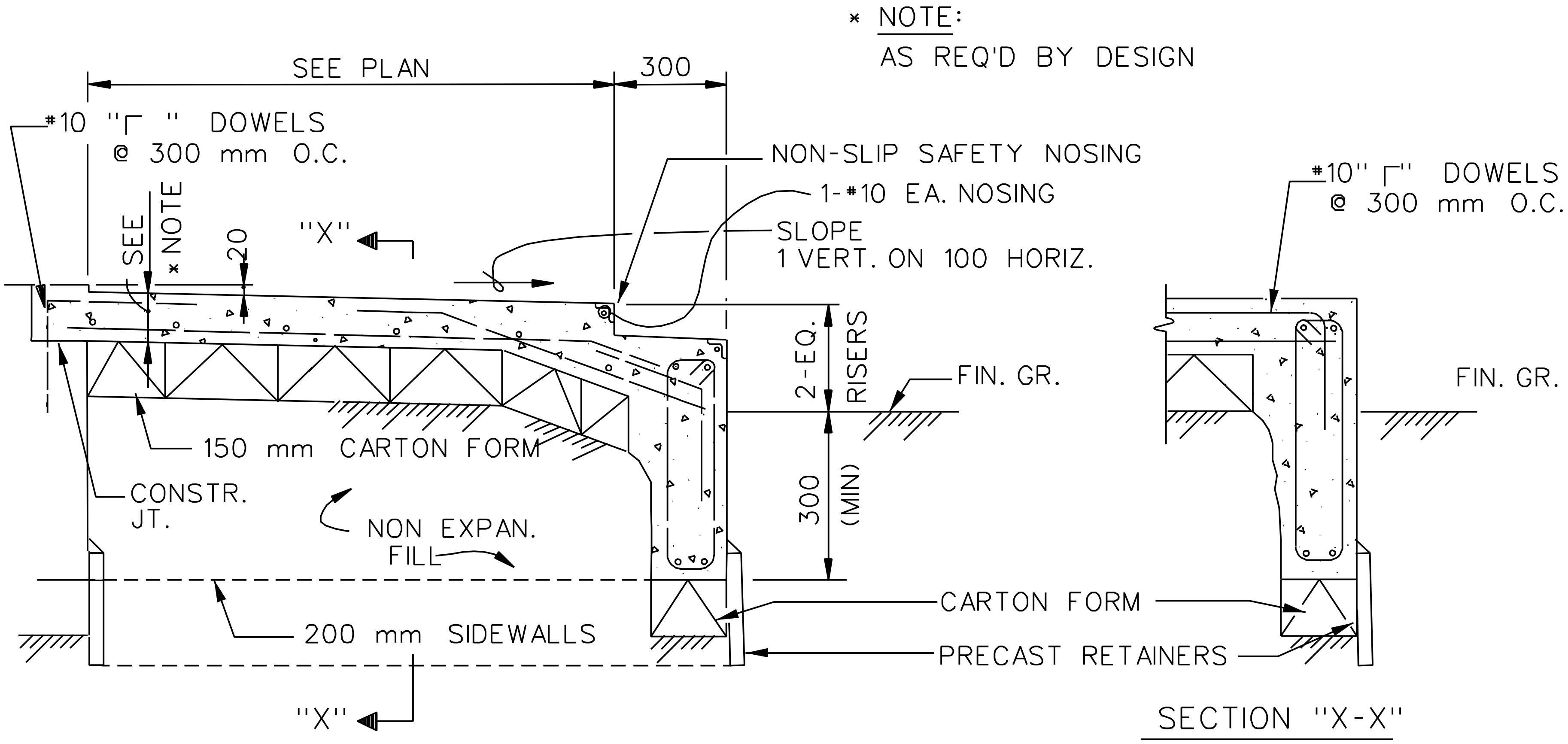
6. TOPPING IS NOT REQUIRED FOR ROOF SLABS.



DETAIL

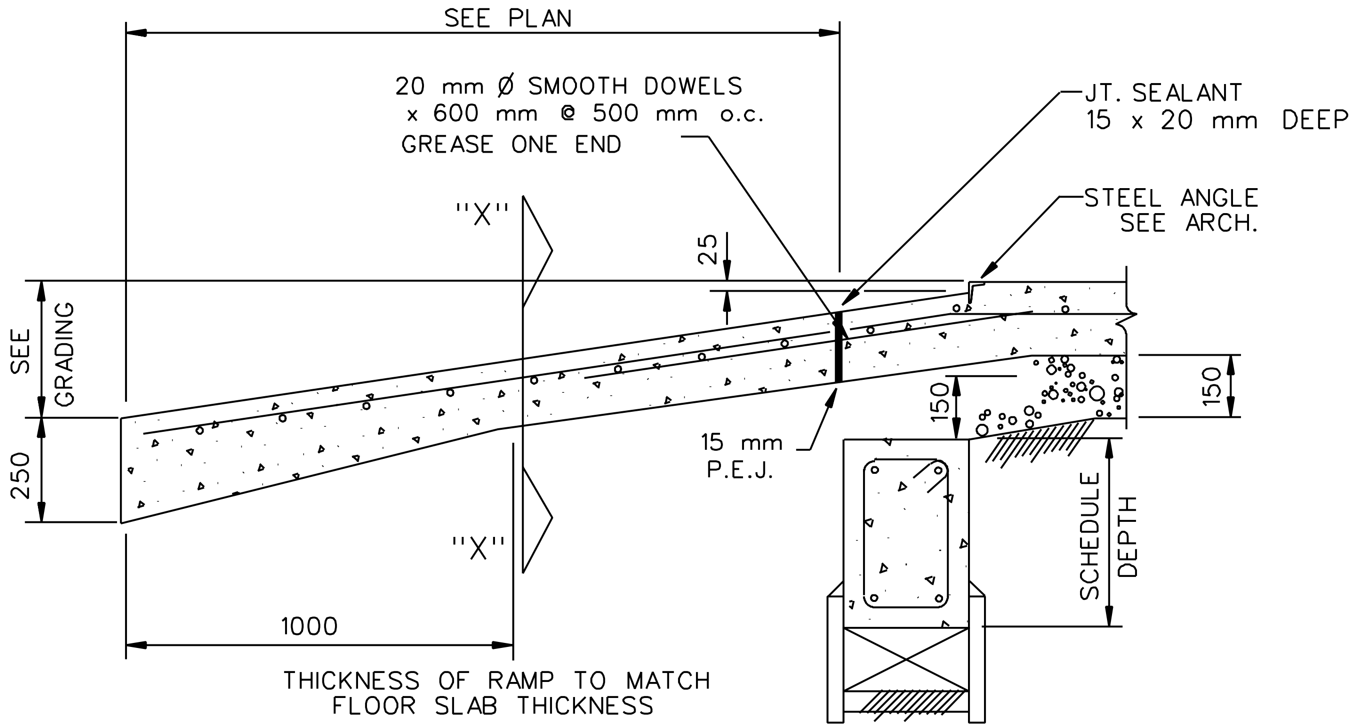
TYPICAL "ARTICULATED" STOOP

PLATE S32

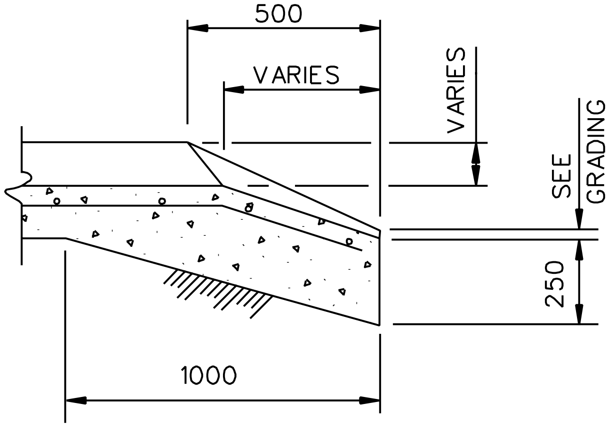


TYPICAL SUPPORTED STOOP

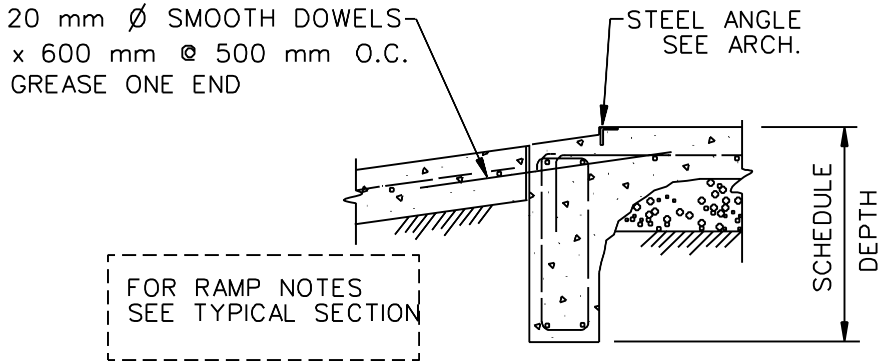
NOTE TO DESIGNER: SEE PLATE S27 FOR VOID DETAIL.



TYPICAL SECTION THRU RAMP TO SLAB ON GRADE FLOOR

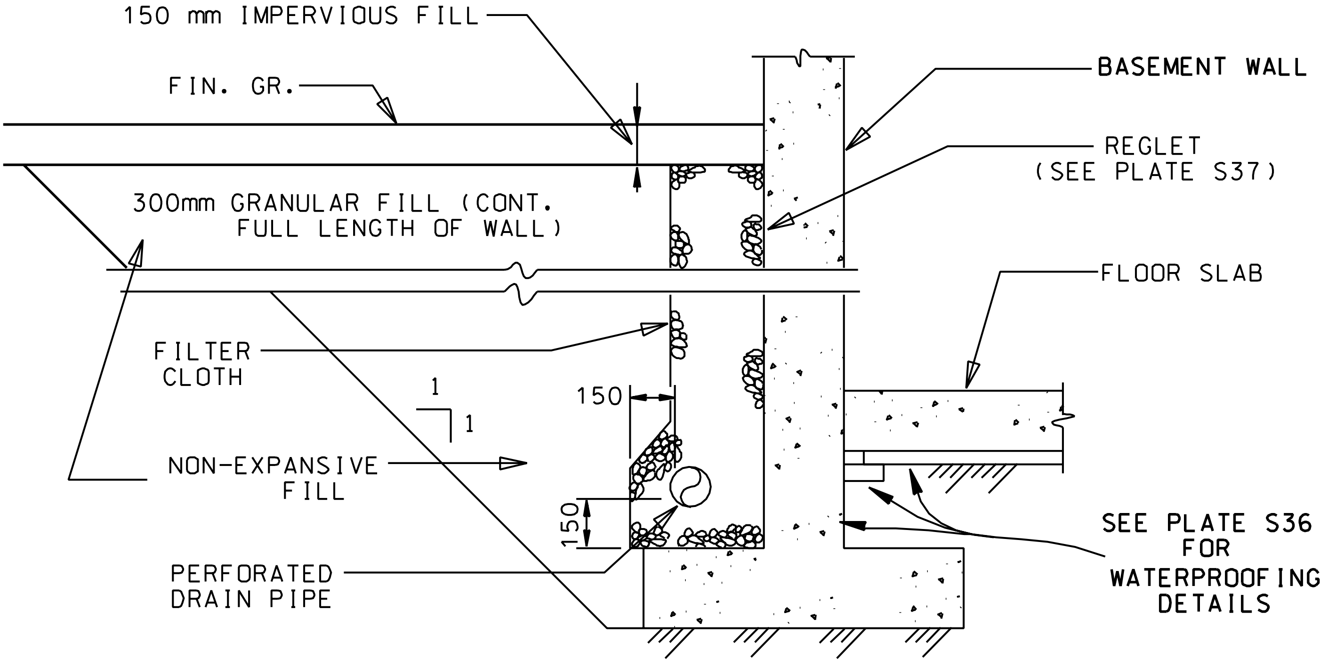


SECTION "X-X"

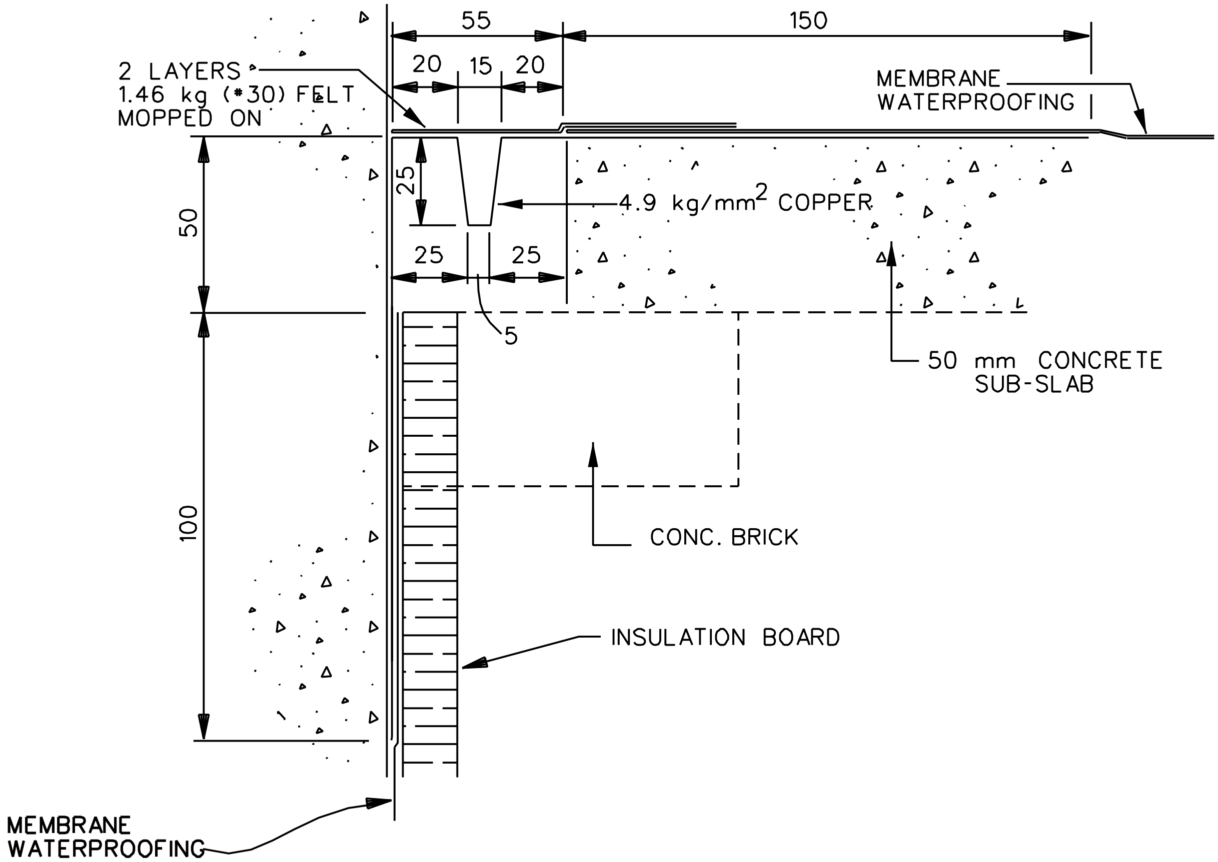


TYPICAL RAMP TO RIBBED-MAT SLAB FLOOR

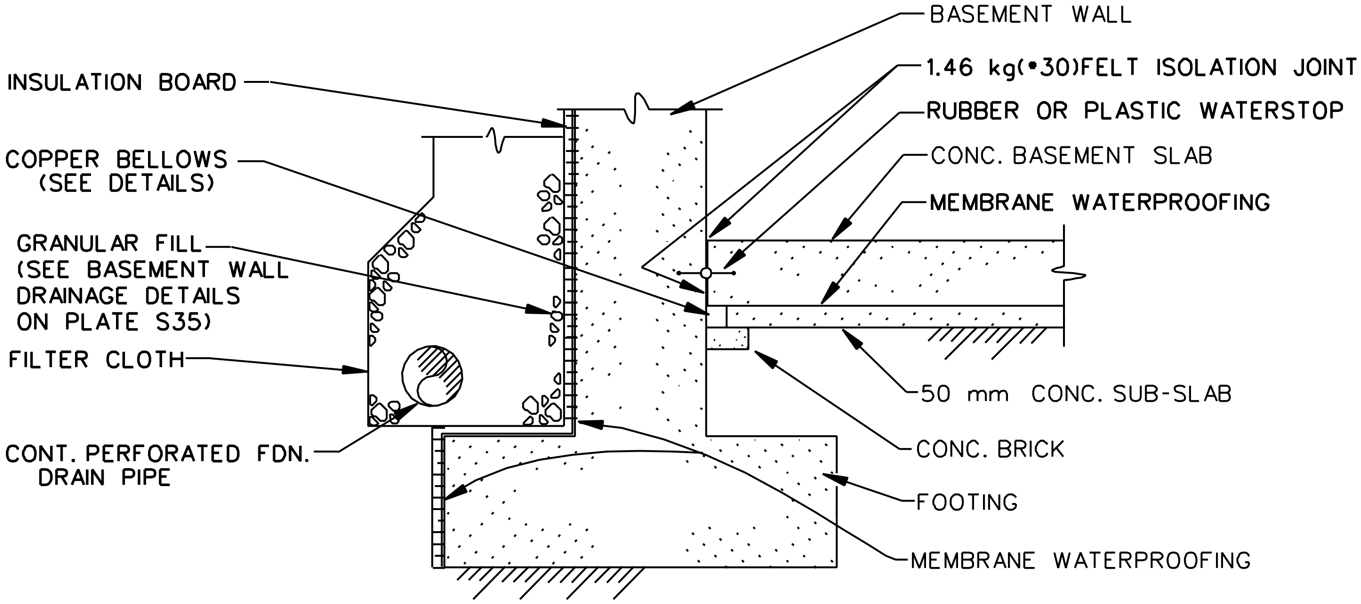
TYPICAL RAMP DETAILS



BASEMENT WALL-DRAINAGE SYSTEM

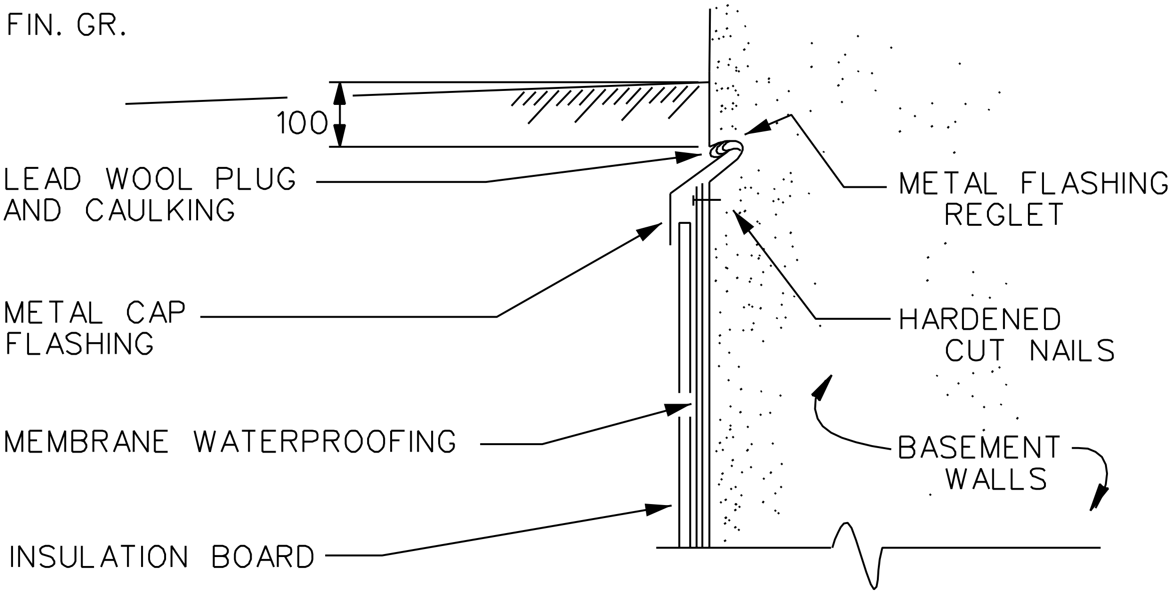


COPPER BELLOWS



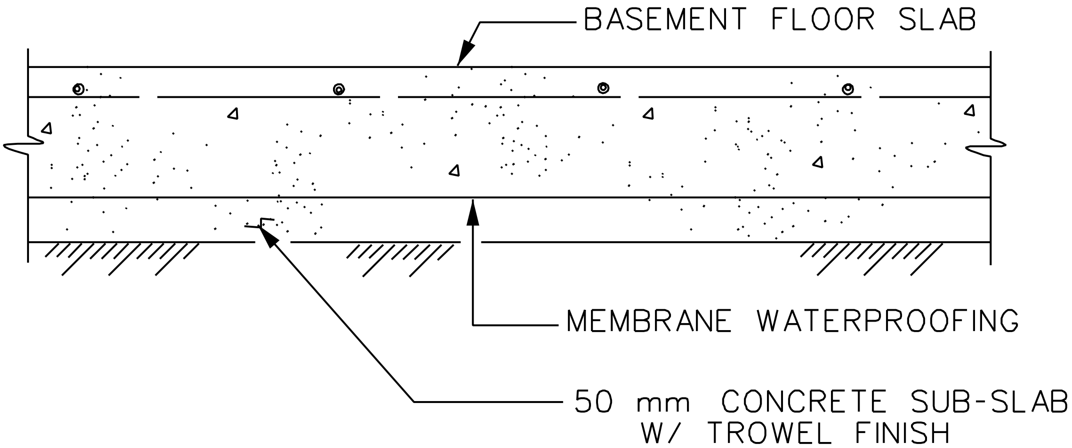
TYPICAL FLOOR TO WALL SECTION

BASEMENT WATERPROOFING DETAILS



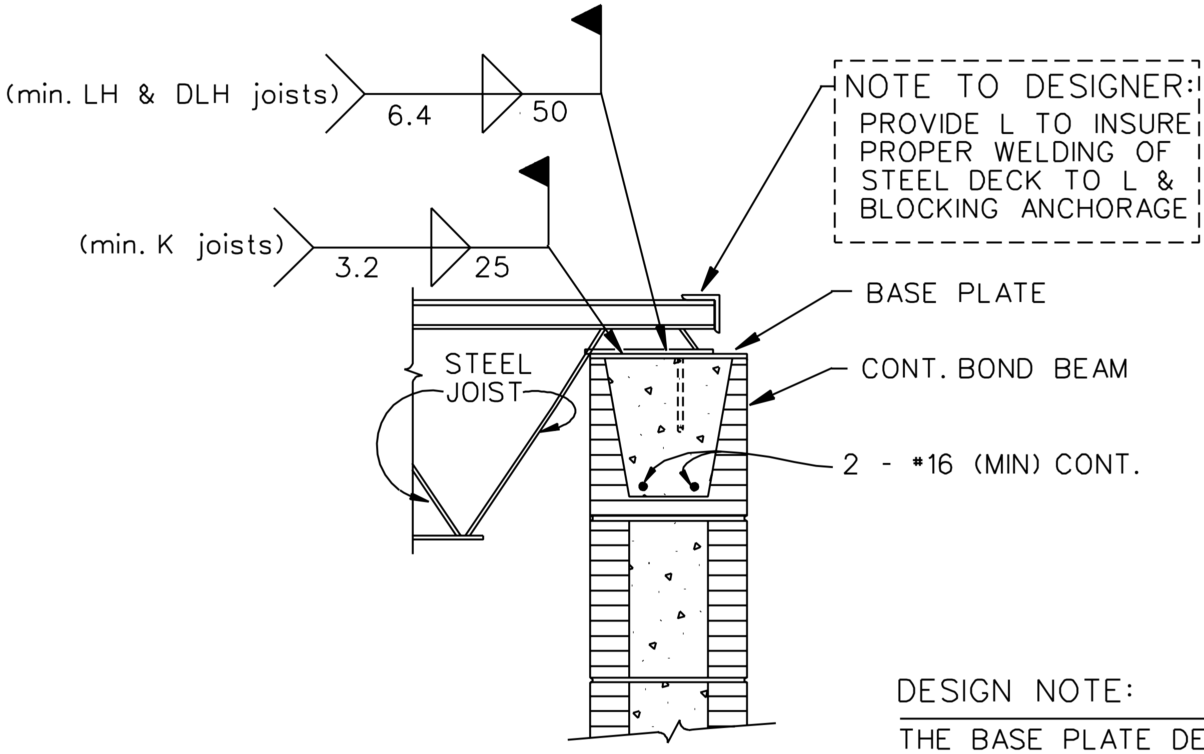
WALL & REGLET DETAIL

(ALSO APPLIES TO EXTERIOR BERMED WALLS)



FLOOR SLAB

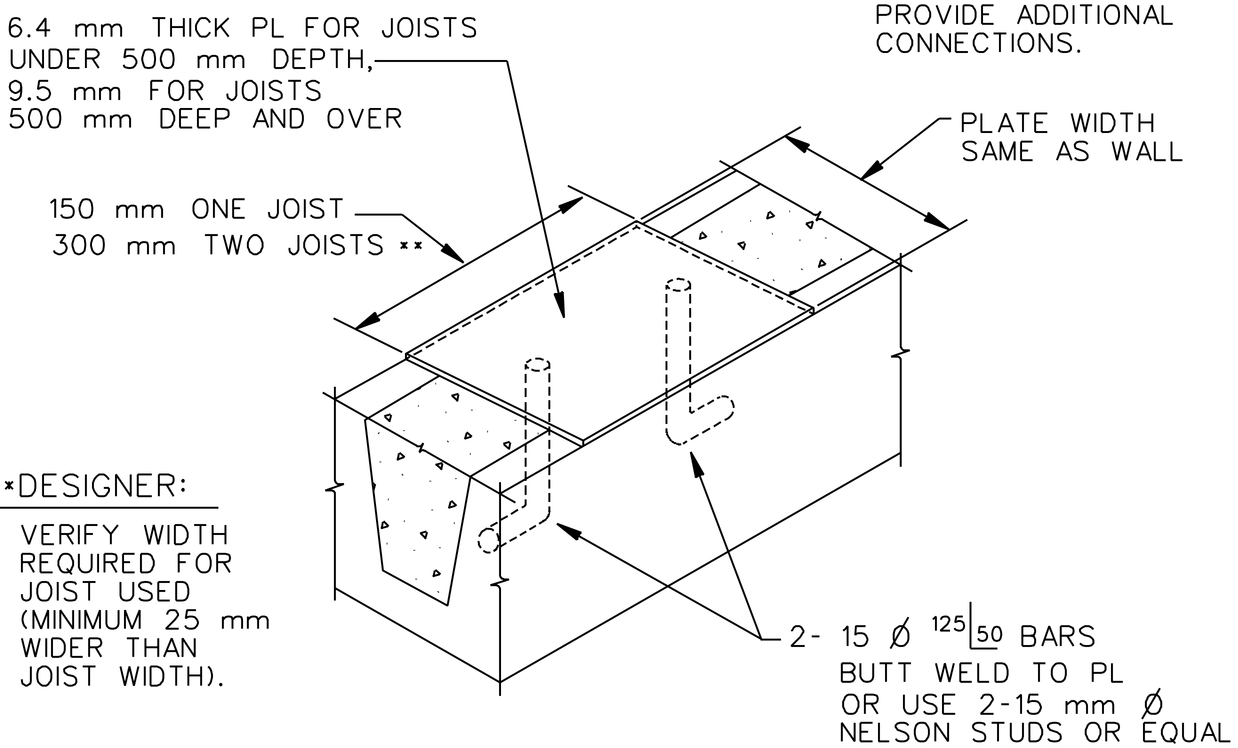
BASEMENT WATERPROOFING



JOIST ANCHORAGE DETAIL

DESIGN NOTE:

THE BASE PLATE DETAIL IS ADEQUATE FOR 4500 N SEISMIC SHEAR OR 9000 N WIND SHEAR (SERVICE LOAD ALLOW) BETWEEN DECK AND WALL. IF LOADS ARE HIGHER ADJUST THE STUD SIZE OR PROVIDE ADDITIONAL CONNECTIONS.

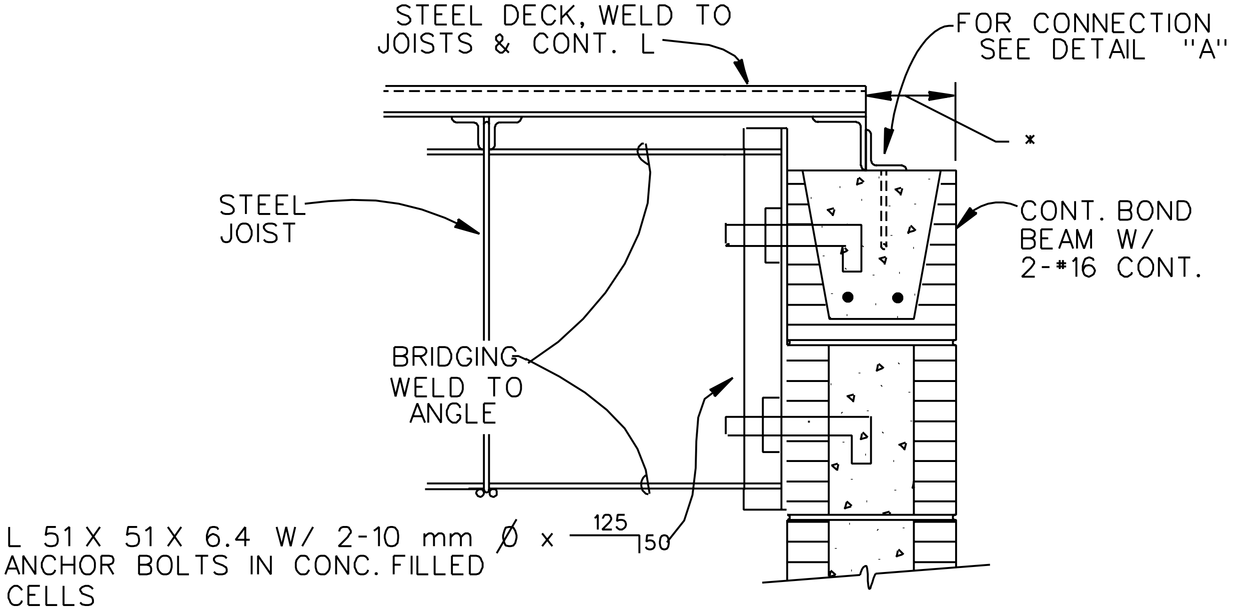


**DESIGNER:

VERIFY WIDTH REQUIRED FOR JOIST USED (MINIMUM 25 mm WIDER THAN JOIST WIDTH).

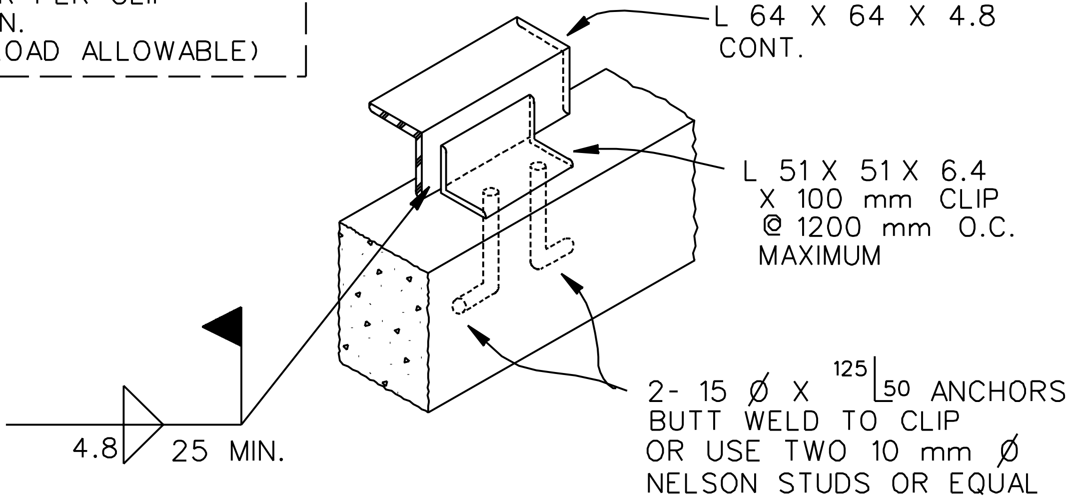
TYPICAL STEEL JOIST BASE LP DETAIL

N.T.S.



SECTION

DESIGN NOTE:
SHEAR CAPACITY 4500 N
SEISMIC SHEAR OR 9000 N
WIND SHEAR PER CLIP
CONNECTION.
(SERVICE LOAD ALLOWABLE)



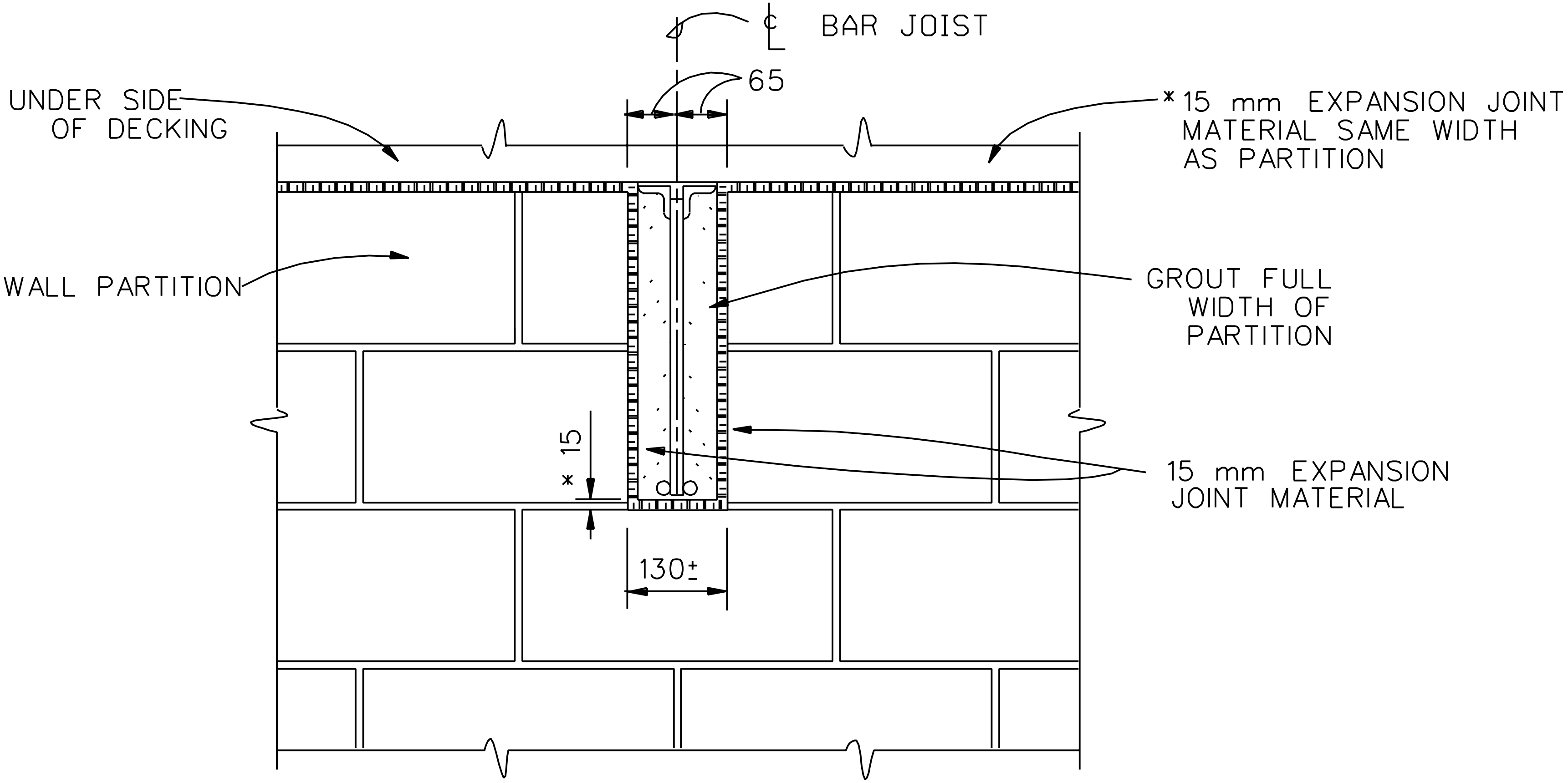
DETAIL "A"

ROOF CONNECTION AT RAKE DETAILS

* NOTE TO DESIGNER: CALL OUT DIMENSION AND COORDINATE WITH ARCHITECTURAL.

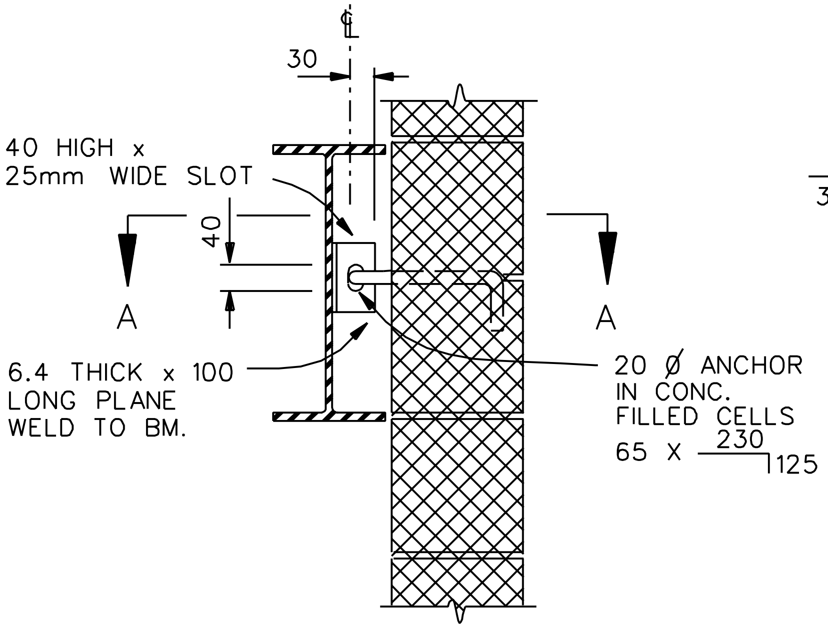
DESIGN NOTE:

THIS DETAIL IS ADEQUATE FOR 3750 N/m SEISMIC SHEAR
OR 7500 N/m WIND SHEAR BETWEEN DECK AND WALL.
IF SHEARS ARE HIGHER ADJUST BOLT SIZE OR CLIP SPACING.
(SERVICE LOAD ALLOWABLE)

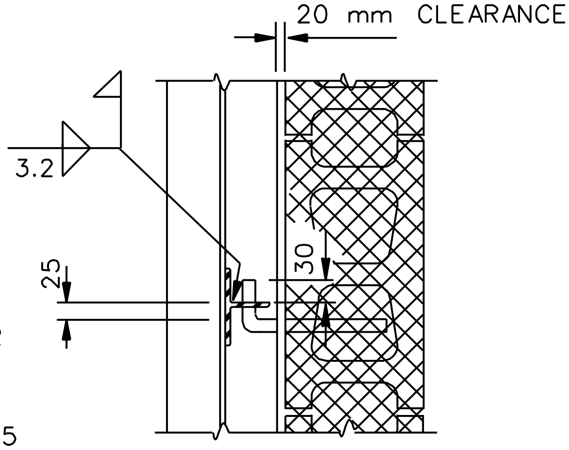


STEEL JOIST & CMU PARTITION INTERSECTION

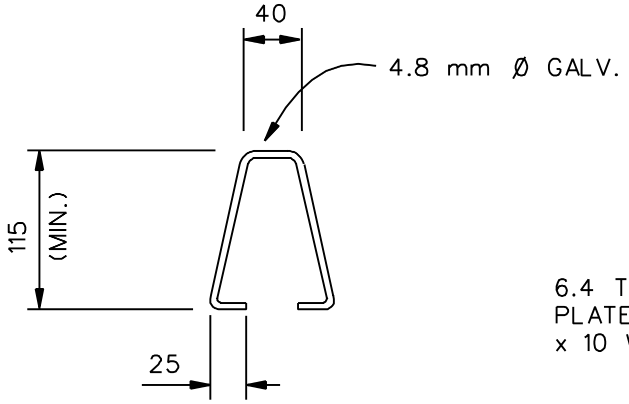
* 15 mm MINIMUM BUT MUST BE INCREASED, IF NECESSARY, TO EXCEED LIVE LOAD DEFLECTIONS.



DETAIL ①

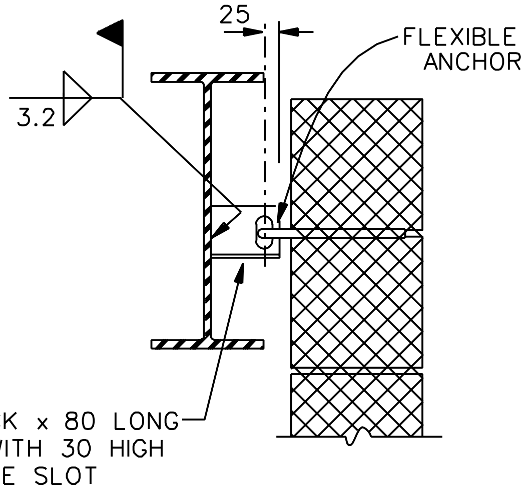


SECTION A-A



FLEXIBLE ANCHOR

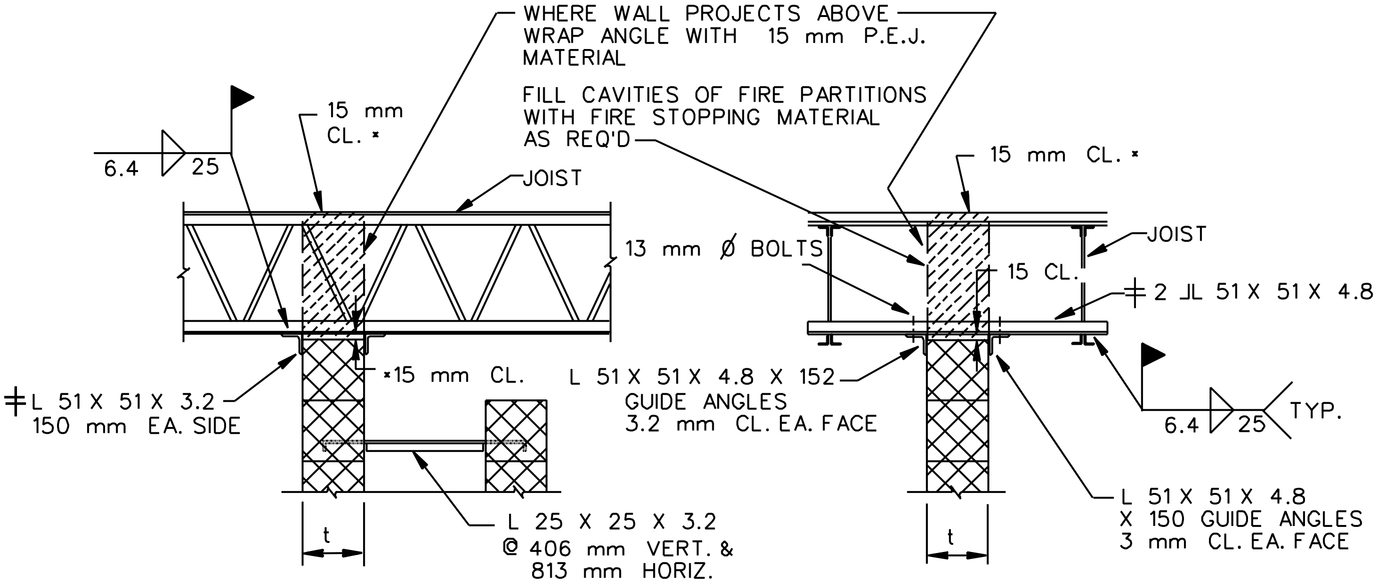
LOAD CAPACITY OF EACH
ANCHOR = 2670 N



DETAIL ②

SELECT ANCHOR SPACING
TO CARRY NORMAL
LOADS ON WALL

WALL ANCHOR TO STEEL BEAM DETAILS

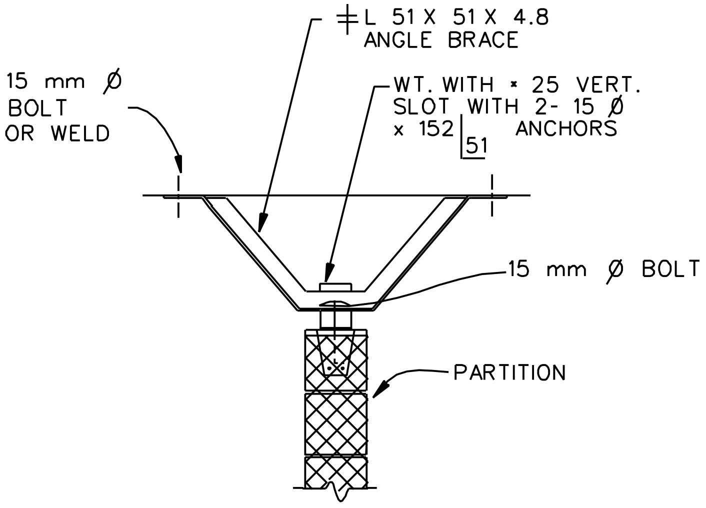


CHASE PARTITION

(FOR ALL SEISMIC AREAS)

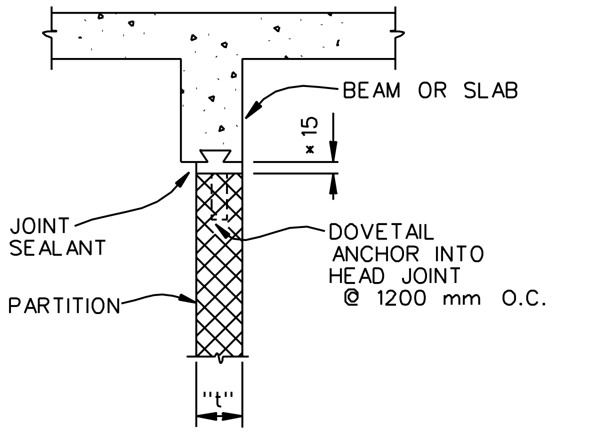
WITH STRUCTURAL STEEL JOIST

(FOR ALL SEISMIC AREAS)



ALTERNATE SUPPORT

(FOR ALL SEISMIC AREAS)



WITH CONCRETE BEAM OR SLAB

(FOR USE ONLY WHEN PARTITION DESIGN PRODUCES NO SEISMIC REQUIREMENTS)

TYPICAL DETAILS of INTERIOR CMU PARTITIONS

NOTE TO DESIGNER:

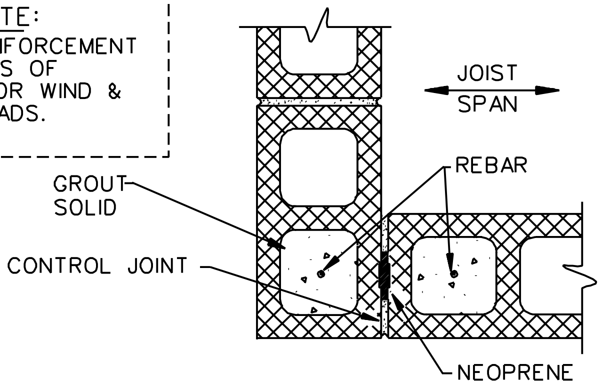
SUPPORT AT TOP OF WALL WHEN DISTANCE BETWEEN LATERAL SUPPORTS EXCEED 36 " t "

* 15 mm DEFLECTION CLEARANCE IS MINIMUM BUT SHOULD NOT BE LESS THAN LIVE LOAD DEFLECTION OF ROOF SYSTEM.

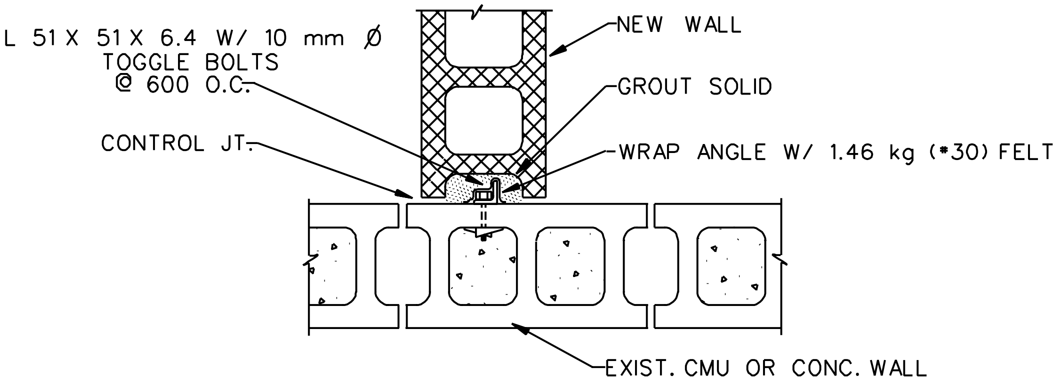
ǂ SPACING TO BE DETERMINED BY DESIGNER

DESIGN NOTE:
CHECK REINFORCEMENT AT CORNERS OF BUILDING FOR WIND & SEISMIC LOADS.

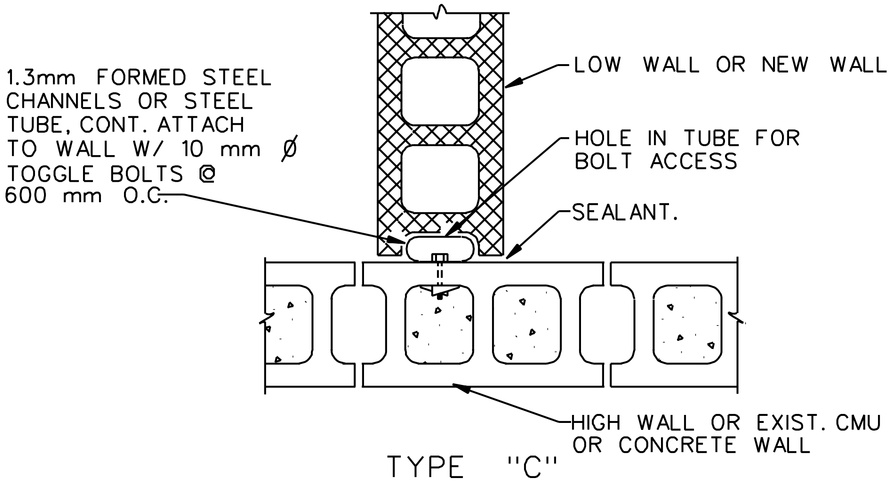
DESIGN NOTE:
TYPE "A" C.J. IS REQUIRED IN ALL LOAD BEARING CONSTR.



TYPE "A"



TYPE "B"

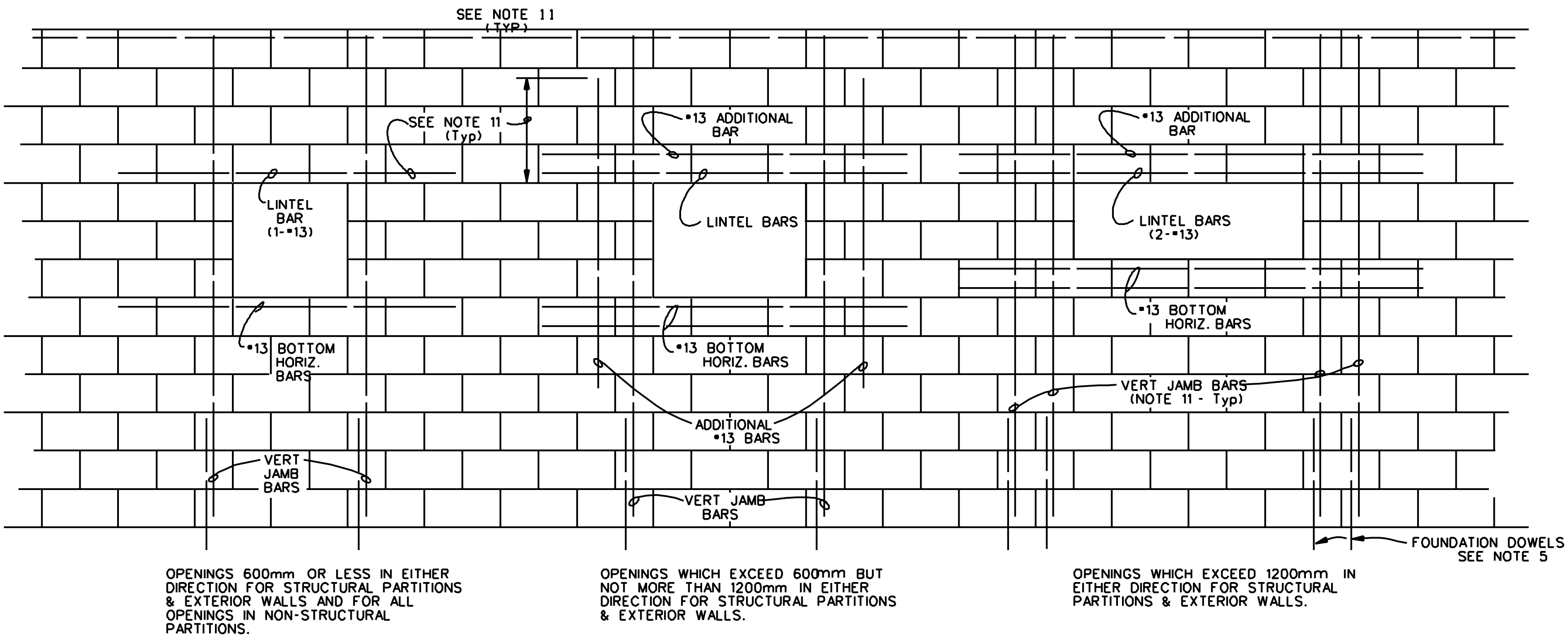


TYPE "C"

SPECIAL CONTROL JOINT DETAILS

NOTE TO DESIGNER:

COORDINATE CMU DETAILS TO MEET ARCHITECTURAL AND STRUCTURAL REQUIREMENTS.
CMU CONTROL JOINT LOCATIONS SHALL BE SHOWN ON THE CONTRACT DRAWINGS.

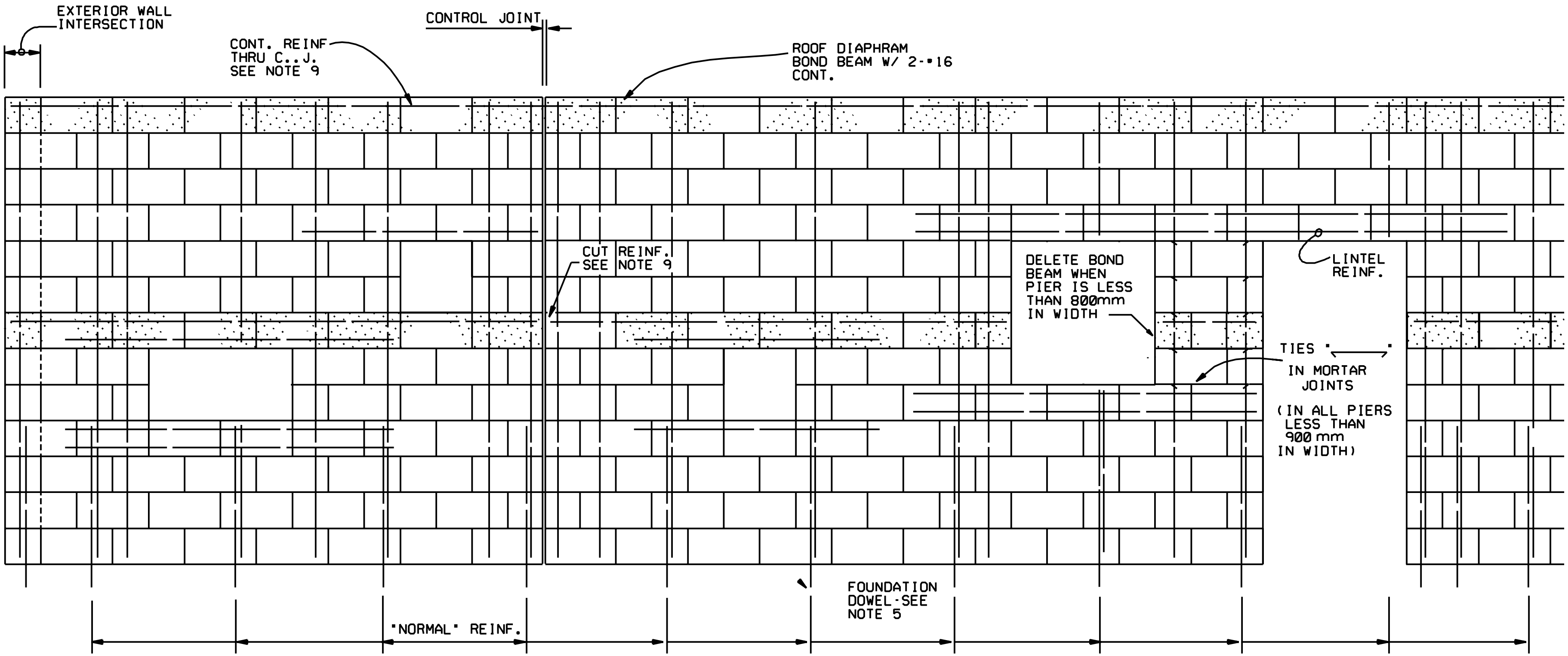


REINFORCED CMU SEISMIC DETAILS

REINFORCEMENT AROUND WALL OPENINGS

SEE "REINFORCED SEISMIC CMU NOTES" ON PLATE S46.

THIS PLATE IS NOT TO SCALE.



OPENING W/LINTEL BOND BEAM COMBINATION

TYPICAL CONTROL JOINT

TYPICAL WALL PIER

TYPICAL REINFORCED CMU SEISMIC DETAILS

SEE "REINFORCED SEISMIC CMU NOTES" ON PLATE S46.
THIS PLATE IS NOT TO SCALE.

REINFORCED HOLLOW CMU (SEISMIC DESIGN CATAGORIES C & D ONLY)

1. ALL CMU SHALL BE 2 - CELL BLOCK AND HAVE A SPECIFIED COMPRESSIVE STRENGTH OF 14 MPa (2,000 psi) ON NET ARE AT 28 DAYS.

2. MINIMUM MORTAR COMPRESSIVE STRENGTH - 12.4 MPa (1,800 psi) AT 28 DAYS.

3. CELLS WHICH CONTAIN REINFORCING STEEL SHALL BE FILLED SOLIDLY WITH 14 MPa (2,000 psi) CONCRETE, OR GROUT, INCLUDING BOND BEAMS, LINTELS AND PILASTERS.

4. VERTICAL CELLS TO BE FILLED SHALL HAVE VERTICAL ALIGNMNET SUFFICIENT TO MAINTAIN A CLEAR UNOBSTRUCTED CONTINUOUS VERTICAL CELL NOT LESS THAN 50 X 75 MM IN PLAN DIMENSIONS.

5. FOUNDATION DOWELS SHALL EXTEND A MINIMUM OF 30 DIAMETERS INTO THE FOUNDATION CONCRETE AND 40 DIAMETERS INTO THE MASONRY WALL OR PARTITION. LAPS OR SPLICES OF REINFORCING STEEL IN MASONRY SHALL BE 600 MM OR 40 BAR DIAMETERS, WHICHEVER IS GREATER. THERE SHALL BE A FOUNDATION DOWEL FOR EACH VERTICAL REINORCING BAR. EXCEPT AS NOTED FOR JAMB BARS IN NOTE 12.

6. VERTICAL WALL REINFORCING SHALL EXTEND CONTINUOUSLY FROM THE TOP OF FOUNDATION TO EMBED AT LEAST 150 MM INTO ROOF DIAPHRAGM BOND BEAM, OR TO TOP OF PARAPET WHEN PARAPET EXITS.

7. AN ADDITIONAL VERTICAL BAR WITH FOUNDATION DOWEL, SAME SIZE AND LENGTH AS THE NORMAL REINFORCING BAR, SHALL BE PLACED.

   A. ON EACH SIDE OF CONTROL JOINTS.
   B. AT INTERSECTION OF EXTERIOR WALLS.
   C. AT INTERSECTION OF INTERIOR SHEAR WALLS W/EXTERIOR WALLS.

8. ALL INTERIOR STRUCTURAL WALLS (SHEAR AND/OR BEARING) SHALL HAVE INTERMEDIATE BOND BEAMS LOCATED AT THE SAME LEVELS AS EXTERIOR BOND BEAMS.

9. BOND BEAM REINFORCING STEEL FOR INTERIOR AND EXTERIOR WALLS SHALL BE CONTINUOUS THROUGHOUT, EXCEPT AT CONTROL AND ISOLATION JOINTS.

   A. AT CONTROL JOINTS INTERMEDIATE BOND BEAM REINFORCEMENT SHALL BE DISCONTINUOUS. REINFORCEMENT IN BOND BEAMS AT FLOOR AND ROOF DIAPHRAGM LEVELS SHALL BE CONTINUOUS.

   B. AT ISOLATION JOINTS ALL BOND BEAM REINFORCING STEEL SHALL BE CUT.

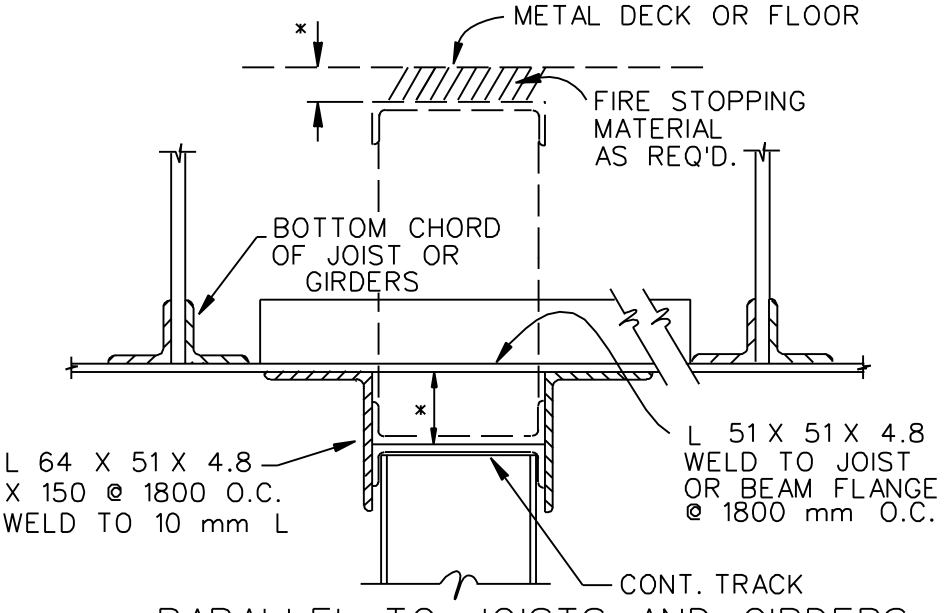
10. LOCATION AND DETAILS OF CONTROL AND ISOLATION WALL JOINTS SHALL BE AS DETAILED ON THE DRAWING.

11. BARS AROUND PERIMETER OF OPENINGS SHALL EXTEND NOT LESS THAN 40 BAR DIAMETERS OR 600 MM, WHICHEVER IS LARGER, BEYOUND CORNER OR OPENING. VERTICAL JAM BARS WILL BE THE SAME SIZE AND NUMBER AS NORMAL VERTICAL REINFORCING. FOUNDATION DOWELS FOR THESE BARS AROUND OPENINGS ARE ONLY REQUIRED WHEN BAR DEVELOPMENT LENGTH DOES NOT EXIST BELOW THE OPENING.

12. HORIZONTAL AND VERTICAL REINFORCING SHALL BE ___________

    (DESIGNERS SHALL COMPLETE THIS NOTE TO DEFINE WALL REINFORCEMENT REQUIREMENTS, INCLUDING JOINT REINFORCING. COORDINATE REINFORCING ON STRUCTURAL AND ARCHITECTURAL DRAWINGS. SEE NOTE TO DESIGNER BELOW.)

NOTE TO DESIGNER:
MINIMUM AREA OF STEEL AND MAXIMUM SPACING OF BARS SHALL CONFORM WITH CHAPTER 11 OF FEDERAL EMERGENCY MANAGEMENT AGENCY PUBLICATION 302, PROVISIONS FOR SEISMIC REGULATIONS FOR NEW BUILDINGS AND OTHER STRUCTURES. THE MINIMUM REINFORCEMENT REQUIRED TO PROVIDE DUCTILE PROPERTIES FOR A SEISMIC DISTURBANCE MAY NEED TO BE INCREASED TO CARRY BUILDING DESIGN LOADS. THE DESIGN STRUCTURAL ENGINEER SHALL DESIGN THE TYPICAL WALL SECTION, LINTELS ABOVE OPENINGS, WALL STIFFINERS AT SIDES OF OPENINGS AND WALL PIERS FOR THE DEAD, LIVE, WIND AND SEISMIC LOADS ACTING ON THE WALL AND INCREASE THE MINIMUMS AS REQUIRED TO CARRY THESE LOADS.

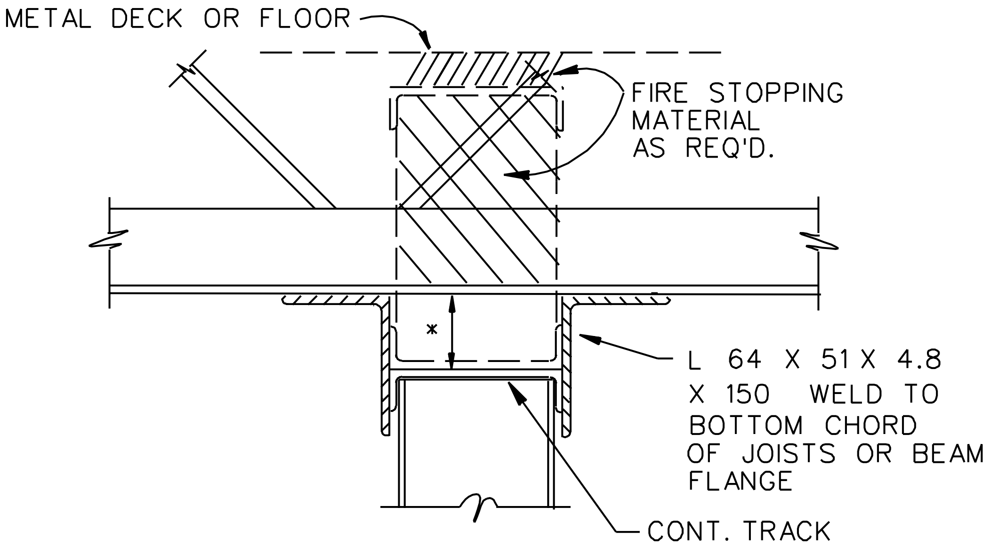


PARALLEL TO JOISTS AND GIRDERS

* MINIMUM CLEARANCE OF 25 mm IS FOR SLAB ON GRADE FLOORS OR 15 mm FOR SUPPORTED OR RIB-MAT SLABS BUT CLEARANCE SHOULD NOT BE LESS THAN LIVE LOAD DEFLECTION OF ROOF OR FLOOR ABOVE.

NOTES:

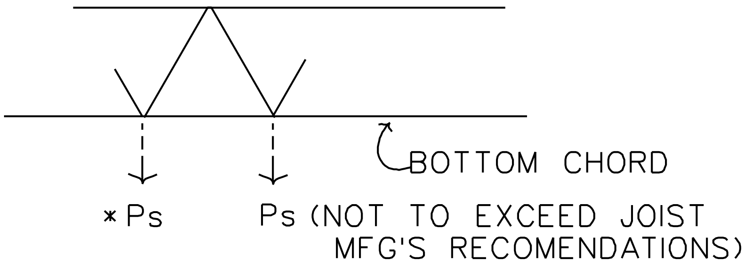
1. WHEN STUDS EXTEND TO DECK OR FLOOR ABOVE, PROVIDE * MINIMUM CLEARANCE WITH LATERAL SUPPORT AT BOTTOM CHORD.
2. OTHER SUPPORT DETAILS WHICH PROVIDE DEFLECTION CLEARANCE AND LATERAL SUPPORT REQUIREMENTS MAY BE USED.



PERPENDICULAR TO JOISTS AND GIRDERS

METAL STUD PARTITION LATERAL SUPPORT

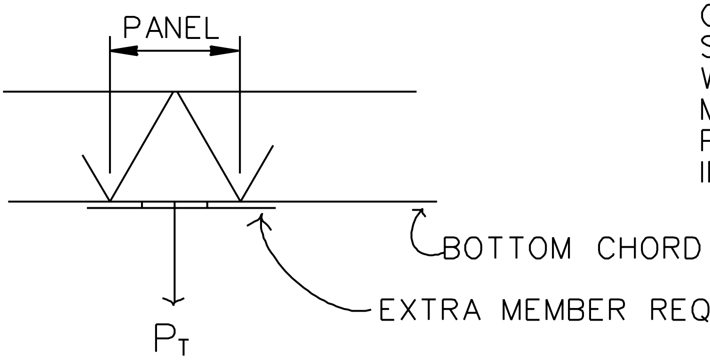
(When Cross Wall Support Spacing Exceeds 2400 mm)



(A) BOTTOM CHORD LOADING
AT PANEL POINTS

* NOTE:

CONTRACTOR SHALL COORDINATE ALL SUPERIMPOSED LOADS WITH THE JOIST MANUFACTURER PRIOR TO JOIST INSTALLATION.



(B) BOTTOM CHORD LOADING
BETWEEN PANEL POINTS

** "P_T" IS THE TOTAL RESULTANT FORCE APPLIED AT MID-SPAN OF JOIST PANEL. IF "P_T" IS IN EXCESS OF 225 N, REINFORCE THE BOTTOM CHORD PER (B) ABOVE. TYP. LOADS INCLUDE CEILING (+), MECHANICAL EQUIPMENT AND ELECTRICAL EQUIPMENT AMONG OTHERS.

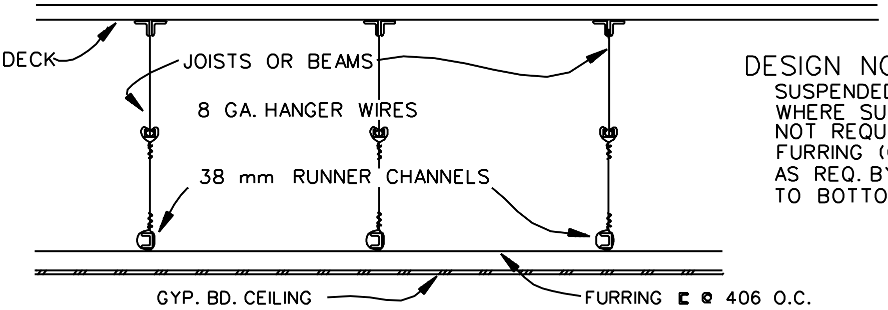
(+) EXAMPLE:

FOR A HANGER SPACING SUPPORTING A ONE SQ. METER AREA THE CEILINGS ARE CONSIDERED TO WEIGH 50 kg/sq. meter.

"P_T" FOR CEILING = $(50kg/m^2)(1.0\ m^2)(9.8N/kg)$ = 490N

DESIGN EXTRA MEMBER FOR LOAD OF 490-225 = 265N

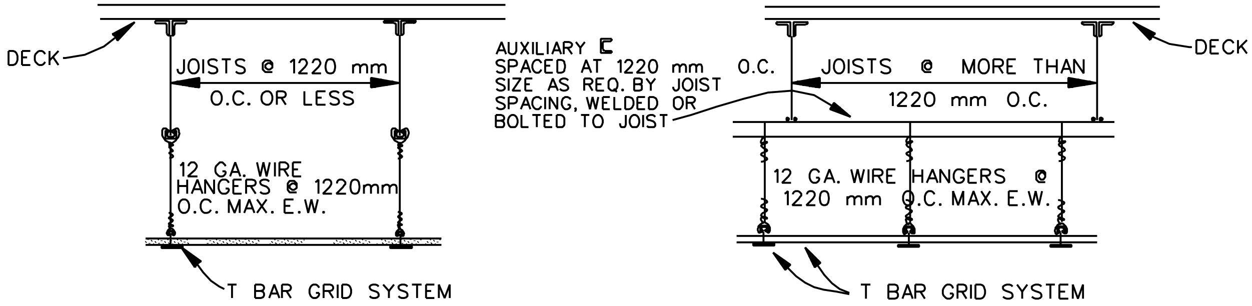
STEEL JOIST BOTTOM CHORD LOADING DETAIL



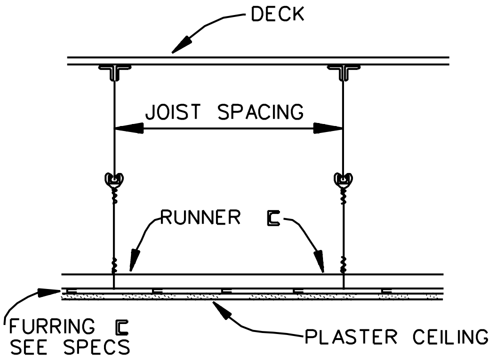
DESIGN NOTE:
SUSPENDED CEILING IS SHOWN. WHERE SUSPENDED CEILING IS NOT REQUIRED, ATTACH FURRING (CHANNELS OR STUDS AS REQ. BY SPAN) DIRECTLY TO BOTTOM OF JOIST OR BEAMS.

MAX. JOIST SPACING	HANGER SPACING	FURRING ⊏ SIZE
1220	1220	0.62 THICK 22
1525	1070	0.62 THICK 41 ⊏
1830	915	0.62 THICK 64 ⊏
2135	915	0.62 THICK 64 ⊏
2440	765	0.62 THICK 92 ⊏

GYPSUM WALLBOARD CEILING



ACOUSTICAL TILE CEILING



JOIST SPACING	HANGER SIZE	RUNNER ⊏ SIZE		RUNNER ⊏ SPACING
914	8 GA.	38	C.R.	1220
1220	8 GA.	38	C.R.	915
1525	6 GA.	38	H.R.	915
1830	6 GA.	38	H.R.	915
2135	6 GA.	51	H.R.	915
2440	B.F.	64	H.R.	915

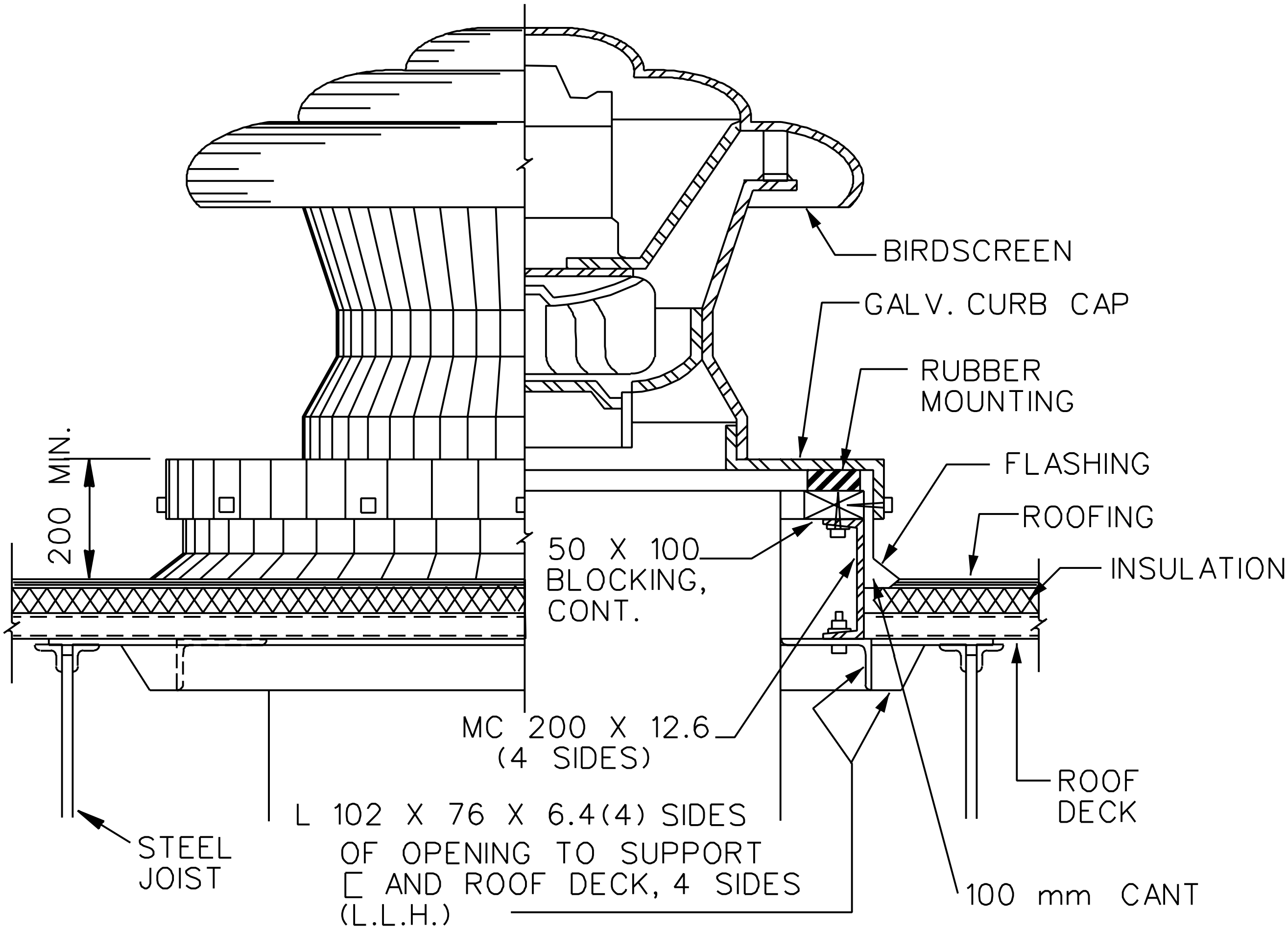
C.R. = COLD ROLLED; H.R. = HOT ROLLED
B.F. = BOLTED FLAT (10 mm Ø BOLTS & 25 X 5 mm BAR)

PLASTER CEILING

SUSPENDED CEILING DETAILS

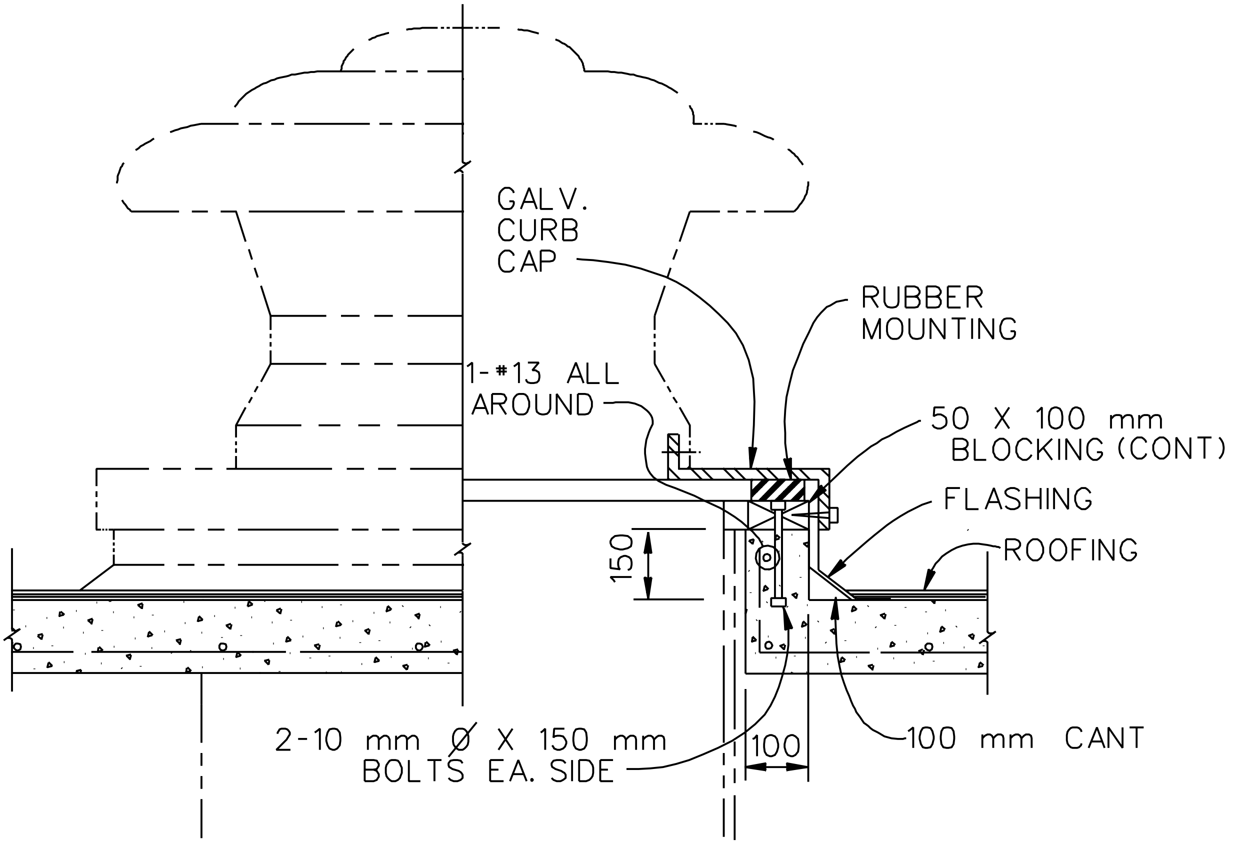
DESIGN NOTE:

1. WHERE HANGER SYSTEM IS INTERRUPTED BY ANY ITEM (SUCH AS MECH. DUCTS) AN AUXILIARY SUSPENSION SYSTEM MUST BE SHOWN. CEILINGS MAY BE HUNG FROM A CONCRETE FLOOR OVER METAL FORM SYSTEM PROVIDED HANGERS ARE PROPERLY DETAILED.
2. SEISMIC DESIGN IS REQUIRED FOR SUSPENDED CEILING SYSTEMS IN STRUCTURES WITH SEISMIC DESIGN CATEGORIES OF C AND HIGHER. SEISMIC FORCES ARE PERSCIRBED IN SECTION 6.2.6 OF FEMA 302.



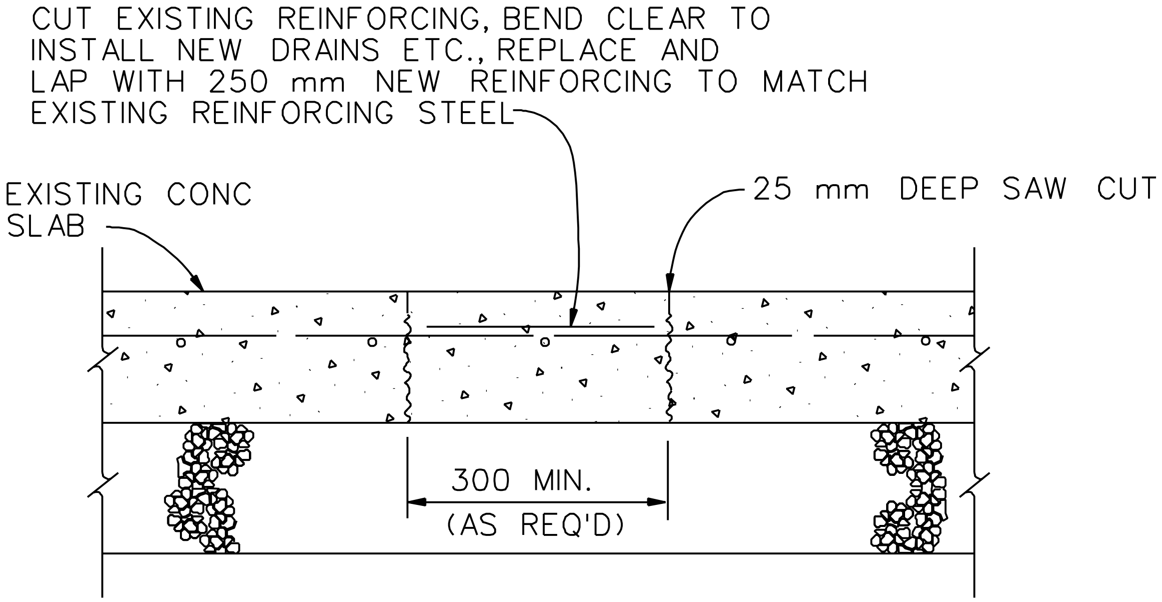
ROOF VENT FRAMING - STEEL CONSTRUCTION

N.T.S.



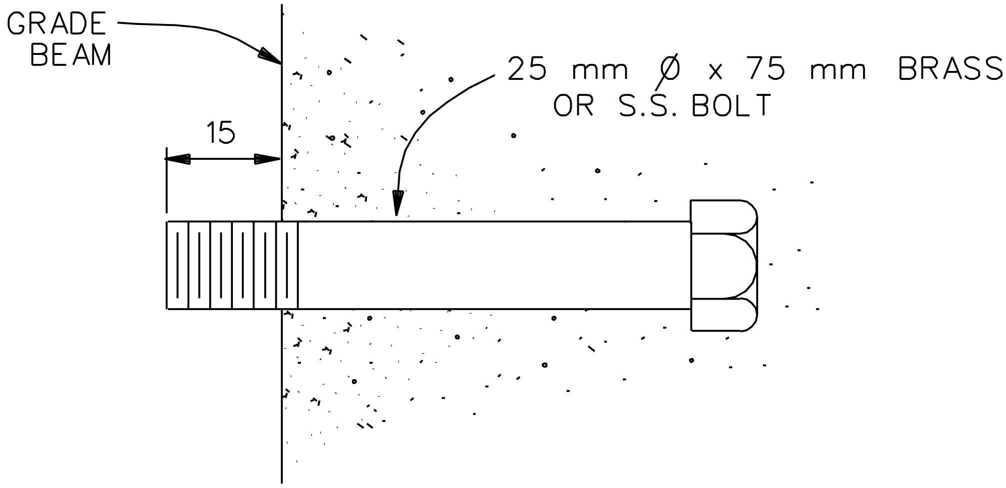
ROOF VENT - CONCRETE CONSTRUCTION

N.T.S.



EXISTING SLAB REMOVAL & REPLACEMENT

FOR NEW FLOOR DRAIN AND PLUMBING



BENCH MARK DETAIL

THE FOLLOWING NOTE TO BE PLACED ON CONTRACT PLANS:

NOTE:

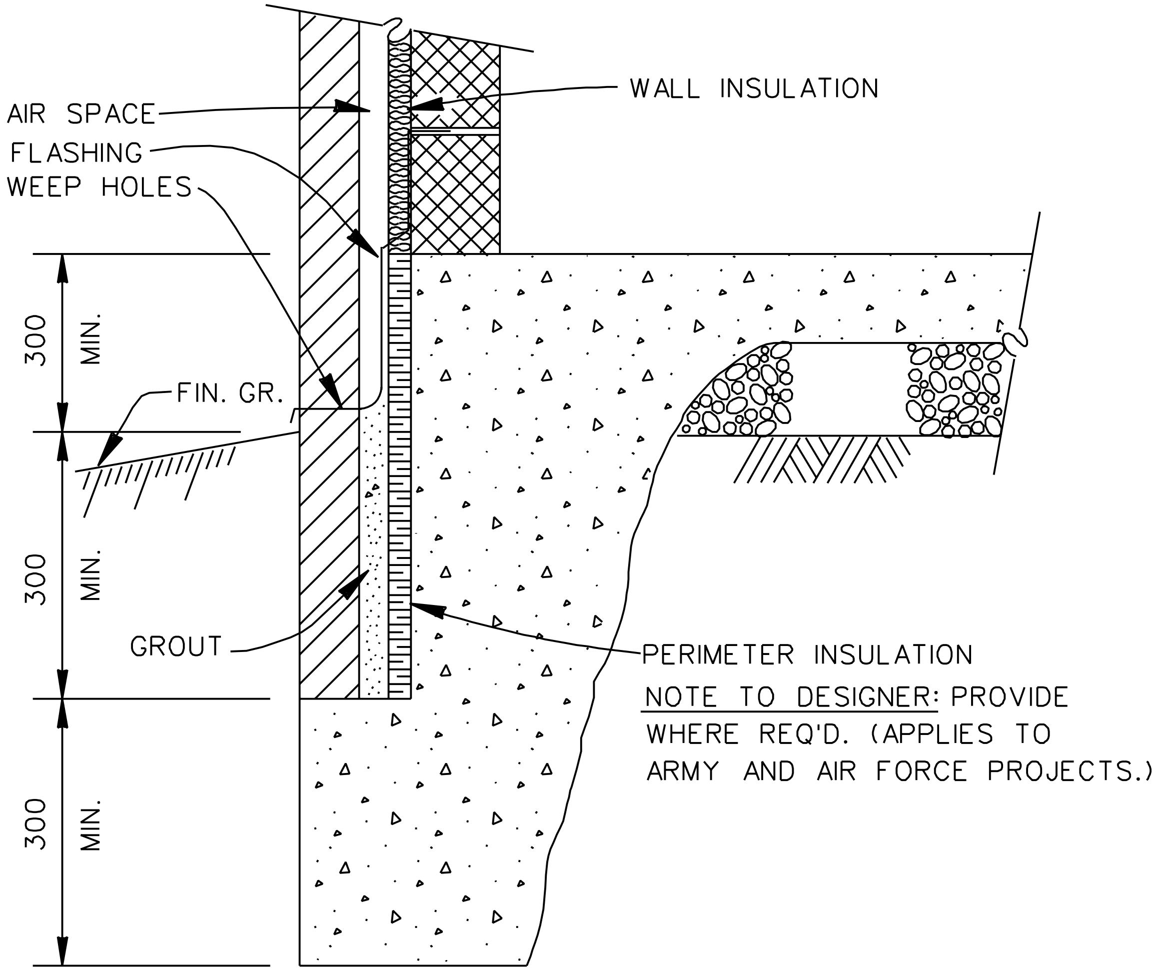
INSTALL BENCH MARK IN GRADE BEAM APPROX. 150 mm ABOVE FINISHED GRADE, WHERE SHOWN ON PLAN. AFTER FORMS ARE STRIPPED, OBTAIN ELEVATIONS AND FURNISH THEM TO THE CONTRACTING OFFICER, TO THE NEAREST 1/1000 OF A METER. PRIOR TO FINAL BUILDING ACCEPTANCE, OBTAIN AND FURNISH AN ADDITIONAL SET OF BENCH MARK ELEVATIONS TO THE CONTRACTING OFFICER.

LOCATIONS OF BENCH MARKS ARE SHOWN ON FOUNDATION PLAN.

DESIGN NOTES:

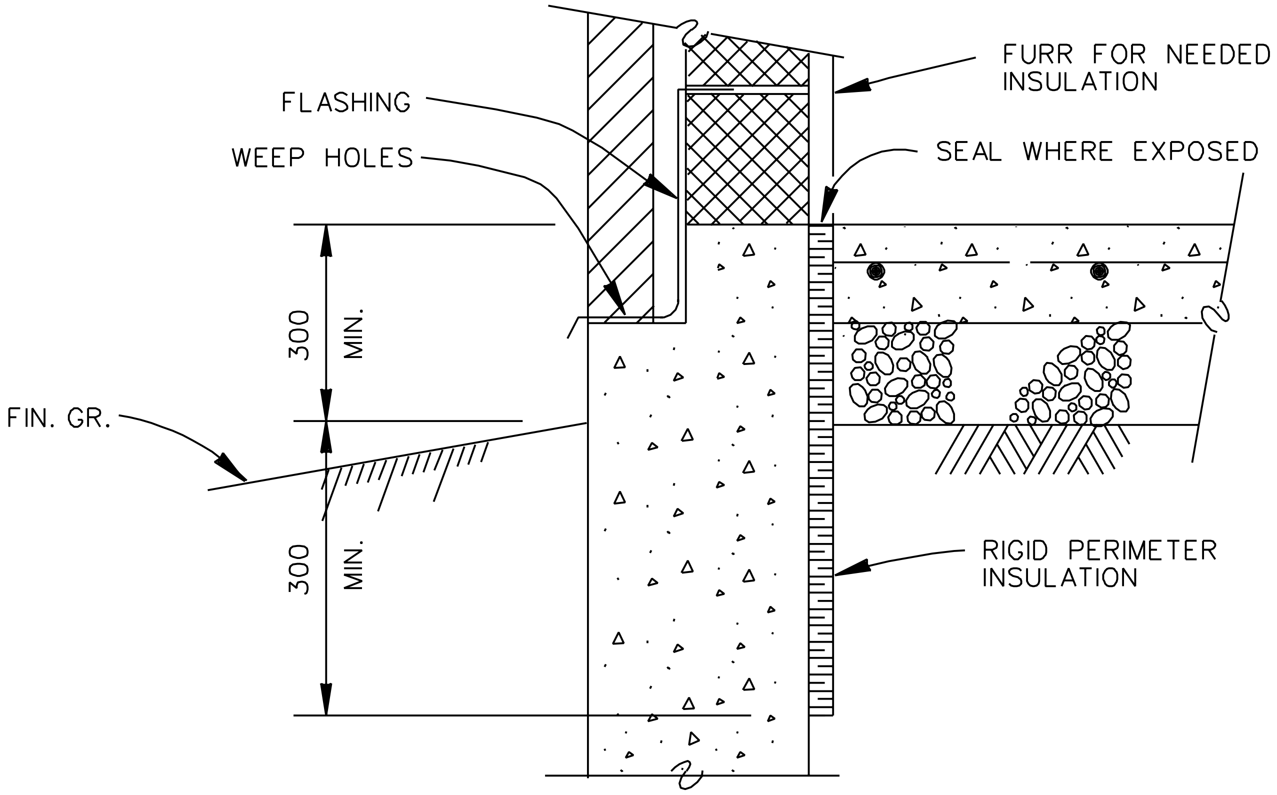
B.M. SHALL BE PROVIDED IN AREAS WHERE EXPANSIVE SOIL CONDITIONS ARE ENCOUNTERED, SUCH AS SAN ANTONIO ("SPECIAL DESIGN" - LOCATIONS).

PROVIDE 3 PER SIDE OF BUILDING, ONE EACH CORNER AND ONE AT ℄ OF BUILDING. PROVIDE ADDITIONAL B.M. TO LIMIT SPACING TO MAX. OF 15 METERS O.C. FOR LONG SIDES. WHEN BUILDING SIDE/S LONGER THAN 50 METERS. PROVIDE A MINIMUM OF 3 B.M. ON EACH PROJECTING LEG OF T AND L SHAPED BUILDINGS.



PERIMETER INSULATION

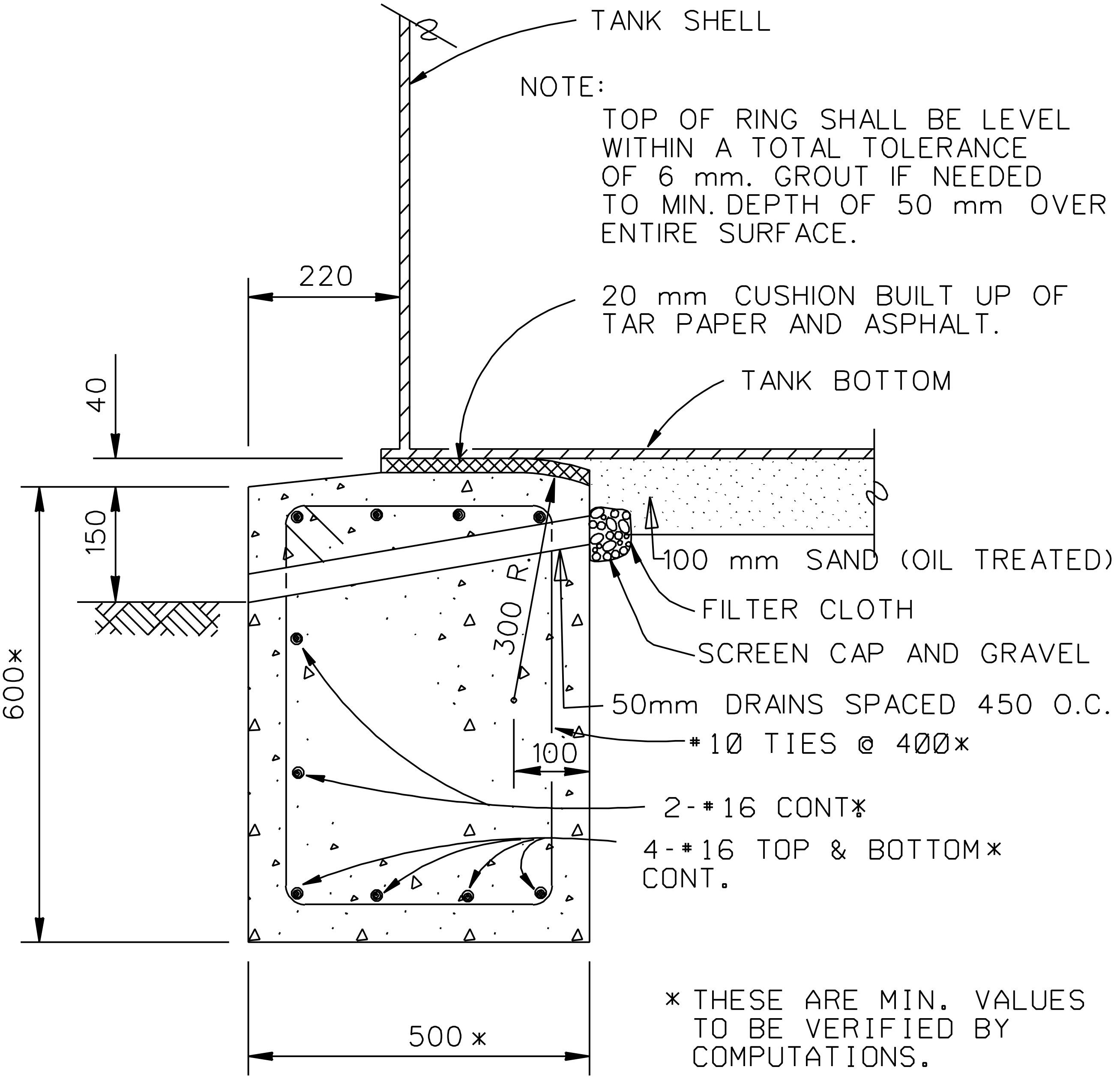
(RIBBED MAT SLAB CONSTRUCTION)



FOR REINFORCED WALLS

PERIMETER INSULATION

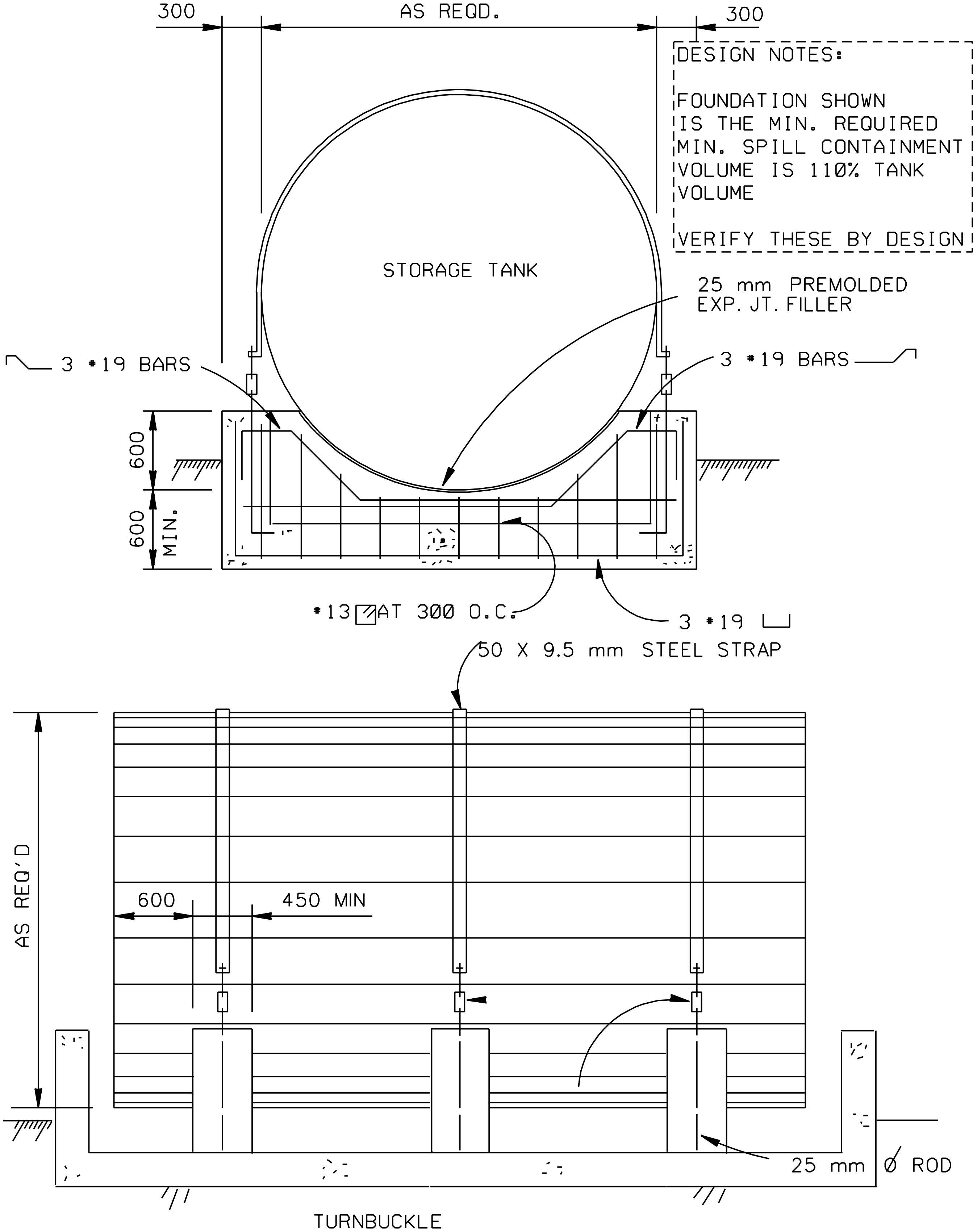
(SLAB ON GRADE CONSTRUCTION)



FUEL STORAGE TANK

(2 100 000 L)

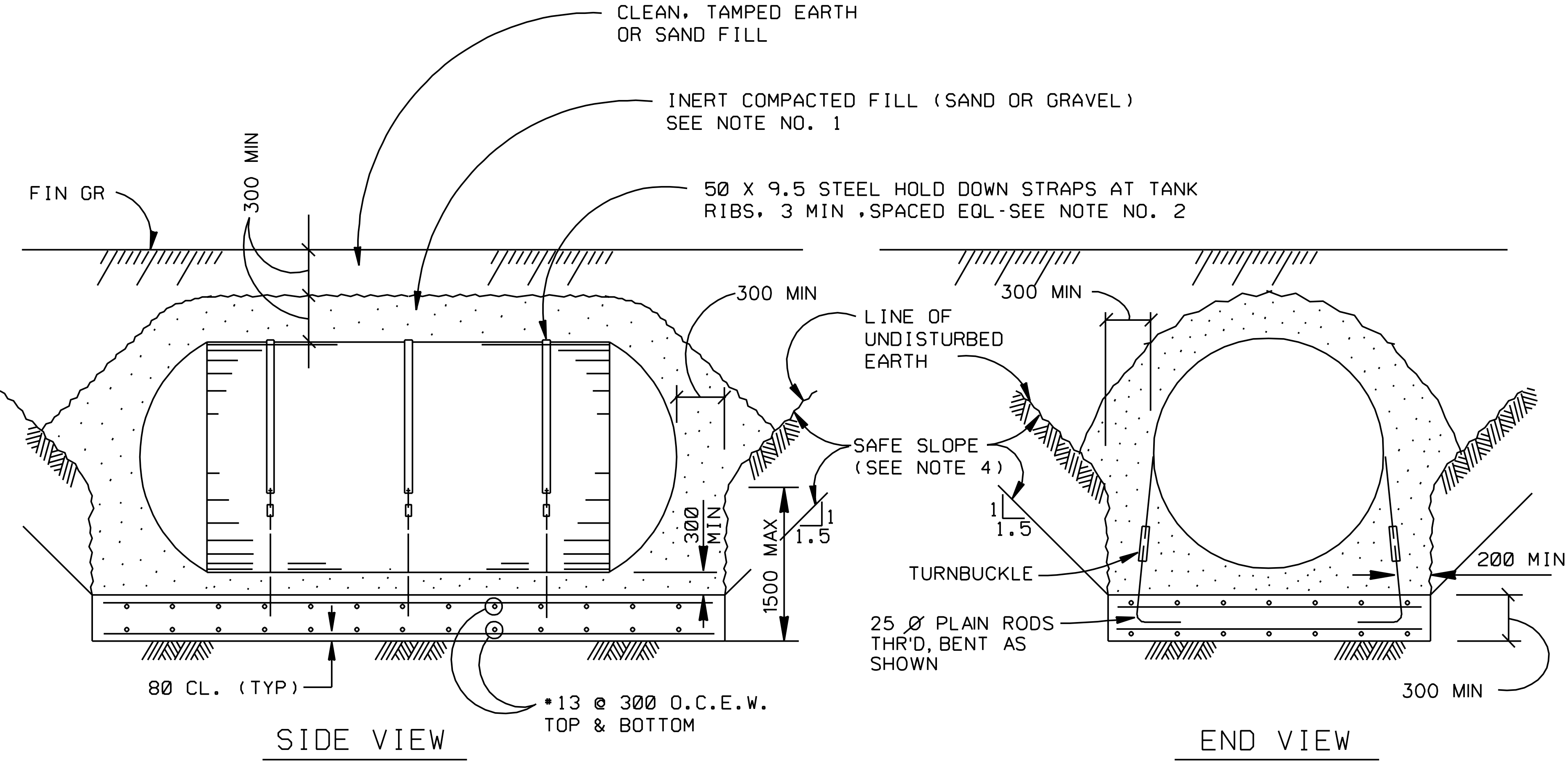
TYPICAL DETAIL
CONCRETE RING FOUNDATION



ABOVE-GROUND STEEL STORAGE TANK FOUNDATION

NORMAL CONDITIONS

PLATE S57



DESIGN NOTES:

1. INERT FILL SHALL BE NATURALLY ROUND AGGREGATED, CLEAN, & FREE FLOWING, W/PARTICLE SIZE NOT LESS THAN 3 mm OR MORE THAN 20 mm DIA.

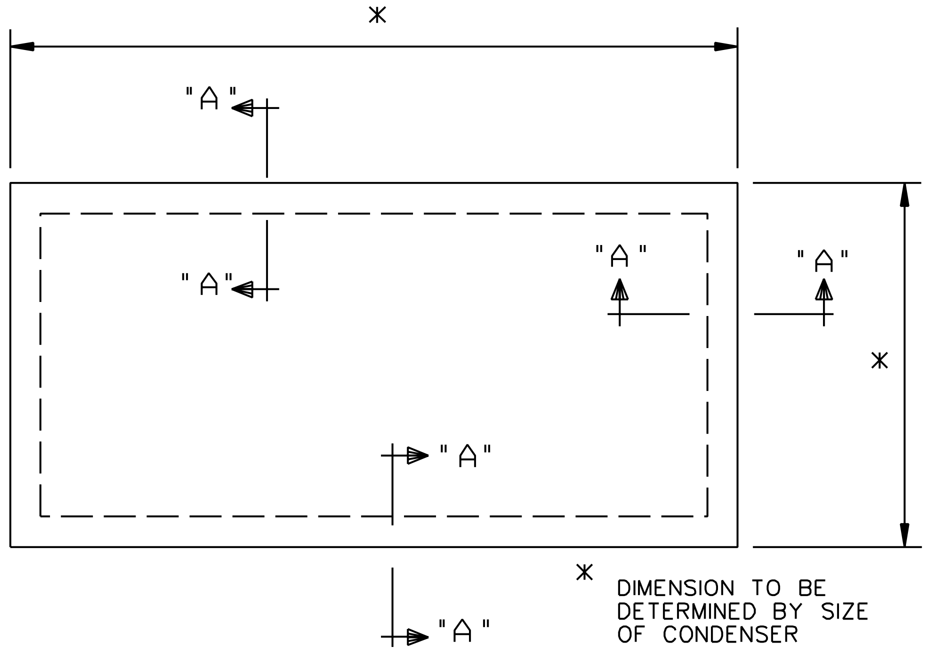
2. CORROSION PROTECTION, SPILL AND OVERFILL PROTECTION, AND LEAK DETECTION SHALL CONFORM WITH EPA 510-K-95-002.

3. DESIGNER SHALL CHECK BUOYANCY CONDITION TO INSURE THESE MINIMUM REQUIREMENTS ARE ADEQUATE.

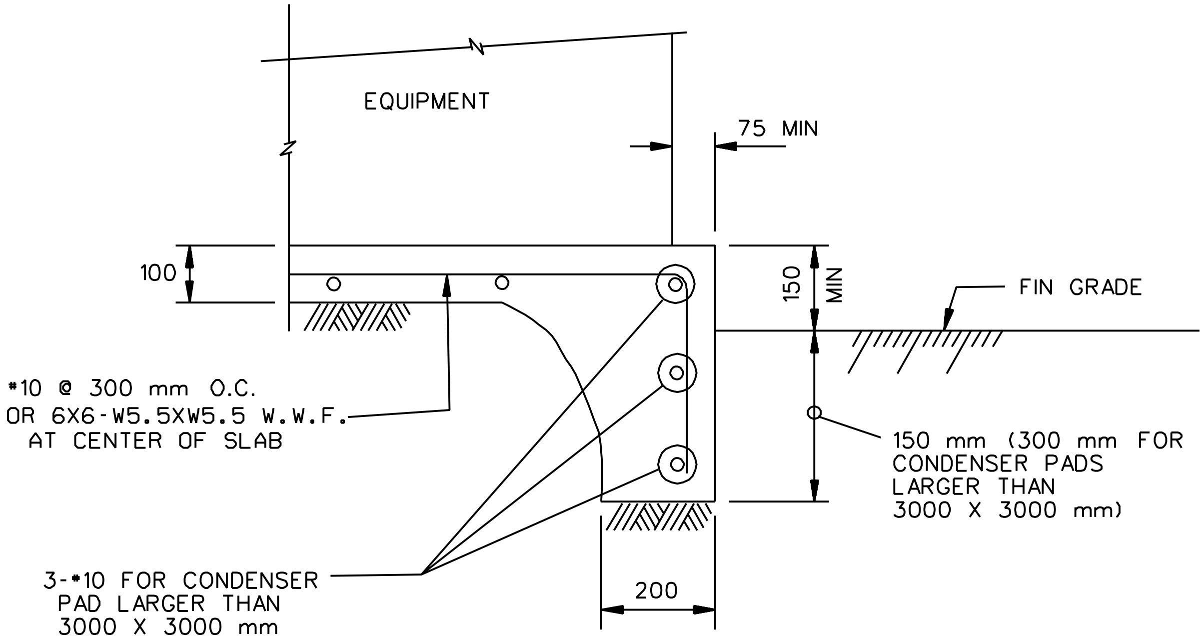
4. STEEPER EXCAVATION SLOPES SHALL BE APPROVED BY A REGISTERED P.E.

PLATE S58

UNDERGROUND FUEL STORAGE TANK FOUNDATION



PLAN

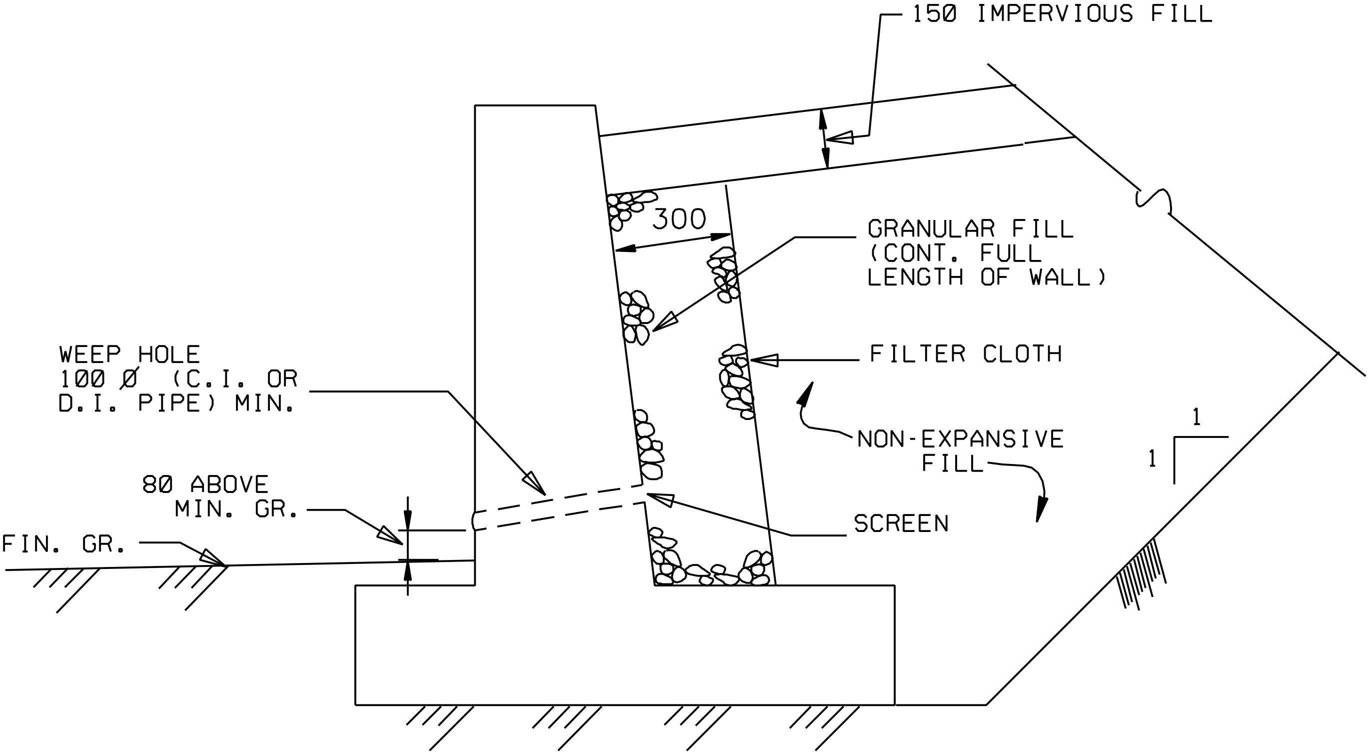


SECTION "A-A"

CONDENSER OR ELECTRICAL EQUIPMENT FOUNDATION DETAILS

NOT TO SCALE

PLATE S59



RETAINING WALL DRAINAGE

APPENDIX B

CHAPTER IV

DESIGN CHECKLIST - STRUCTURAL

STRUCTURAL. The checklist lists many important items required for quality structural plans that comply with Corps of Engineers Criteria. It is not a comprehensive checklist of items to assure that structural plans are complete.

1. Pier and grade beam schedules should coincide with foundation/floor plans, details and other associated data.

2. Foundation, grade beam and slab dowels and their spacing should be identified on plan or by detail.

3. Identify all materials below slabs-on-grade and ribbed mats including non-expansive fill capillary water barrier and vapor barrier.

4. Show locations and provide details for all construction joints, weakened plane joints, isolation joints, contraction joints in slabs-on-grade and ribbed mats.

5. Structural steel framing members shapes, sizes, etc. should be detailed in accordance with the AISC Manual of Steel Construction. For large buildings, provide a column schedule as well as any other tables and schedules that would simplify the drawings.

6. Critical steel connections should be detailed. If simple steel connections are not detailed, verify that the Engineer of Record will approve the structural adequacy of connection details selected by the steel fabricator and give sufficient beam reaction information on the drawings for design of the connection.

7. Provide details for joist seats requirements for sloped end bearings, details of joist wall penetrations and identify bearing elevations. Check that the required strength of top chord extensions and extended ends is specified. Show loads and dimension any special joist configurations for design of special joists by the joist manufacturer on drawings.

8. Foundation, floor and roof plans should have a north arrow and have column grid lines that coincide with the architectural drawings.

9. Provide general notes in accordance with the AEIM.

10. Show control and expansion joint locations for CMU walls and provide details for them. Identify minimum bearing dimensions for beams on masonry.

11. Identify horizontal and vertical CMU wall reinforcing on the details or by table. Verify that the in-wall stiffeners, adjacent to wall openings and piers between openings, are structurally adequate for horizontal and vertical loads.

12. Provide lintel details and a lintel schedule for large buildings.

13. Identify metal deck fasteners and their spacing for floor and roof diaphragms.

14. Provide connection details between floor and roof diaphragms and shear/load bearing walls and/or steel framing.

15. Verify that the spacing, depth, thickness and section modulus for light gage steel studs and joists for walls, roof and floors are shown. Verify that the connection of the wall track to the floor and details of the track at the top of the wall are adequate to carry wall horizontal loads and/or isolate the stud wall from the frame deflection in accordance with the design assumptions. Verify that the studs adjacent to openings are adequate to carry horizontal wall loads. Provide details showing stiffeners and bracing and/or schedules showing number and size for connectors between light gage steel framing members and between this framing and the building structural frame are shown.

16. When standing seam metal roofs are used, show the design wind uplift pressures for the roof on the plans, and detail sub-purlins and their connection to the building frame as required for support of the standing seam roof.